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OCTOBER 3, 1911.

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POWER

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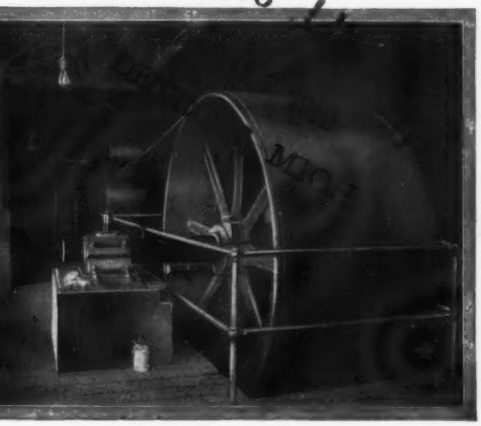
PUBLIC

RHOADS LEATHER BELTING



A QUICK DELIVERY

At 9 A. M. on the 6th of last month, we received a wired order from a mill 185 miles away for 98 ft. of 40-inch three-ply Gilt Edge Leather Belt to be put on endless that week-end. The belt left our factory by express on the afternoon of the 8th. It arrived on the evening of the 9th, and was on the pulleys next morning.

This shows the promptness with which we can help our customers when they are in a tight place.

Not only was the delivery prompt, but the belt of splendid quality. We do not expect another order for this drive for years or decades.

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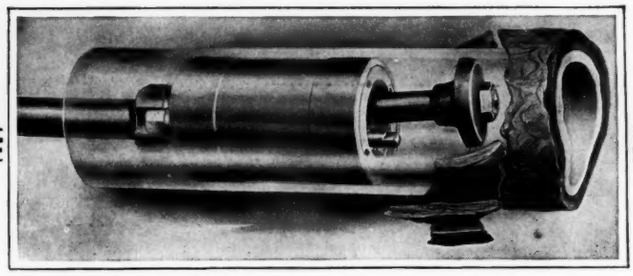

The Dean Removing Scale from the Tube of a Return Tubular Boiler

Do You Know Or Only Think You Know?

That's The Question Suggested To Us By The Story of The Engineer Who Thought He Knew

There was once an Engineer who was ambitious and whose desire it was to run his plant as it should be run:—

At the highest point of efficiency *all the time.*

And so he took care that the feed water was first class and saw that the boiler was cleaned out frequently.

The Inspector complimented him on the condition of the boiler, and its steaming quality seemed O.K.

Wherefore the Engineer thought there was no scale in his boiler—in fact, he was ready to swear it.

But one day came a Manufacturer of a boiler tube cleaner and talked with the Engineer, but he was still sure he knew there was no scale.

Well, to make a long story short, a cleaner was put in on trial and the Engineer *saw four hundred pounds of scale* taken from two boilers.

Let us add that this story is not fiction, but an actual fact. If you will but turn to page 418 of the Sept. 12 issue of POWER you will find it there under the heading "Clean, or Pretty Clean."

And the cleaner referred to in that article is the **Dean Boiler Tube Cleaner.**

The easiest, quickest, most economical and *surest* way of removing scale from the boiler.

It goes where no inspector can. It leaves every tube through which it travels as clean as a gun barrel.

The user of a Dean *knows positively* that his boiler is free from scale, because the Dean has the right principle—

But that is another story. The proof of the pudding is the eating.

And you can prove the money-saving value of Dean Boiler Tube Cleaners by letting us send you one on free trial.

Shall we?

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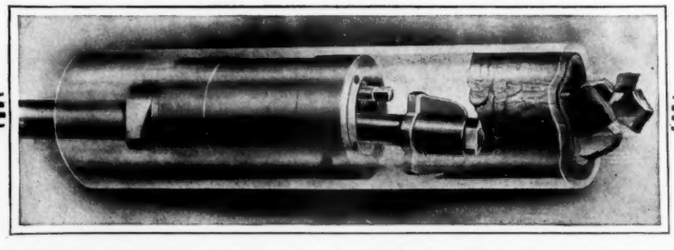
Chicago Office: 801 Steinway Bldg. ***Jewett Building, Buffalo, N. Y.***



The Dean Removing Scale from the Tube of a Water Tube Boiler

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You'll Be Glad, Too, That You Sent For Them

After you receive the Can of Keystone,
the Grease Cup and the Engineer's Cap

For each of them is something that you need, something that will make your work more agreeable as well as more profitable for the man who employs you.

You will see for yourself that Keystone Grease has no waste; it reduces friction to a minimum; it will not gum; it contains no tallow, fats, soapstone or any injurious substances and it is not soluble in water.

Keystone Grease is applied to bearings by pressure grease cups. The development of frictional heat is not required to cause the grease to feed. The original density of Keystone Grease never changes under the severest conditions of speed pressure and atmospheric heat and cold.

Keystone Grease holds the world's record for the lowest coefficient of friction. We guarantee that no other lubricant on the market can compare with it in quality.

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A SAMPLE FREE

KEYSTONE LUBRICATING COMPANY, Phila.

Please send us a large size sample of Keystone Grease, sufficient for testing purposes, and one Brass Grease Cup and Free Engineer's Cap. It is thoroughly understood that no charges whatsoever will be made for sample, cup or cap and all express charges will be paid by you.

Name of bearing where sample will be tested.....
Its width.....Combined horse power of engines.....
Tap size of cup.....
FIRM.....
Per .....
City .....State.....
Size cap required.....**CUT OUT THIS COUPON AND MAIL IT TO-DAY** Dept. B—10-3-11

To Engineers:

You positively cannot get better Globe, Angle or Cross Valves than

Lunkenheimer "Renewo" Valves

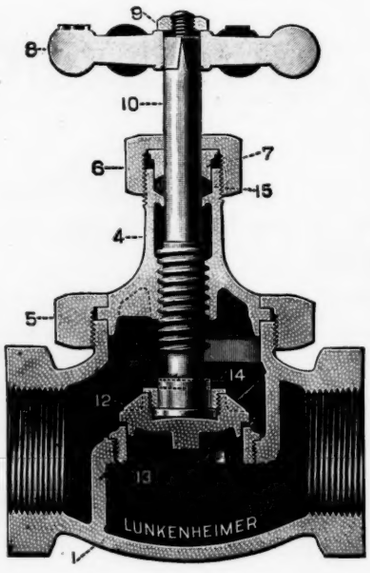
So why waste time in trying

For DURABILITY and PRACTICABILITY they have no equal

When you consider that the SEATING SURFACES of these valves CAN BE REGROUND a number of times; that every part of the valves including the SEAT and DISC CAN BE RENEWED when worn; that the SEAT is SELF CLEANSING; that the material used in the body and other trimmings is a bronze composition containing a high percentage of copper and tin; excepting the SEAT which is made of a HARD CLOSE-GRAINED NICKEL; that the areas throughout the valve body are LARGE and UNOBSTRUCTED, and that the workmanship cannot be excelled, DON'T you think them worth a trial?

Ask any engineer who has ever used LUNKENHEIMER "RENEWO" VALVES and if you will be guided by his advice we feel satisfied that you will adopt them,

Don't forget that they are made by THE LUNKENHEIMER COMPANY, a firm that GUARANTEES ALL OF THEIR PRODUCTS and that while most supply houses carry them in stock those that don't can get them for you if you simply SPECIFY and INSIST on having LUNKENHEIMER "RENEWO."



Lunkenheimer "Renewo" Globe, Angle And Cross Valves

are made in two patterns,—medium and extra heavy,—guaranteed for working pressures up to 200 and 300 pounds per square inch respectively. They are furnished in sizes ranging from ¼ to 3 inches inclusive. Your dealer can furnish them. If not, write us.

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POWER

Vol. 34 NEW YORK, OCTOBER 3, 1911 No. 14.

JUST as the Old Man was saying: "Yes, McClatchy, we have had our eyes on you for some time. When we want facts about our plant, we have only to come to you and we get them; you know your business; you are the best engineer we ever had; you are industrious, faithful to your duties, ever ready to do more than we pay you to do; you do not grumble, and we are satisfied with you; you deserve some substantial appreciation. Now, beginning next week, your wages will be increased to—"

McClatchy woke up! His faithful Ansonia had called the turn just when Mac dreamed that some real appreciation was heading his way.

Old Noah Webster has a good many short, but pointed, stories in his dictionary, and in one of them he relates that a "dream is that which is presented to the mind by the imaginative faculty; to have indefinite thought or expression."

Our thoughts are far from indefinite and our faculties keen these days when the alarm on our mental clockwork wakes us up to the fact that, somehow, we must increase our weekly stipend if Johnny is to stay in school, and Lizzie to become a teacher, and Mamie to keep on at the business college.

If we would better our condition, we must look on our work in the light of a business problem; we must regard our skill, experience and intelligence as purchasable commodities, and ask the old man to pay us what our services are worth to him.

Of course he will say: "Show me how I can profit by such an investment and I will willingly put up the money."

What Jock McClatchy only dreamed has come true to many a live-wire engineer who tackled his job from the business side and knew just *what* he was doing, and *why*.

He was not backward in letting his superiors know what he knew, either, and they were willing to pay him good money for his services, because the company made a profit by the transaction.

To successfully run a power plant these hustling days, one must have business as well as mechanical skill. In almost every issue of this paper is told the experience of men who say they never could have made good if they had not conducted their plants according to business principles.

Wake up! That the old plant has heretofore managed to keep its head above the business waters without strengthening the banks of the levee, is the best of reasons for piling up new sacks of method, energy and push.

Some fine day—perhaps not so very far off, either—something is going to burst alongside the old standstill plant, and the inrush will engulf it.

Wake up! But wake up to the fact that to win out you must fight with every bit of energy that is in you.

Get into the front ranks of the army of General Hustle and hike for the top of Success Hill.

Producing Power from the Sun's Rays

By A. D. Blake

By the use of stationary mirrors the sun's rays are directed against a sheet-iron vessel containing water. This is changed into steam at atmospheric pressure, which is used in a low-pressure condensing engine for pumping water. The commercial practicability of the apparatus depends upon its performance in tropical regions where fuel is expensive.

It has long been recognized that all forms of energy owe their existence to the sun, but the ways in which this solar heat is converted into useful energy are many and often complex. For instance, the potential energy in coal may be traced to the action of the sun upon growing vegetation centuries ago. The coal is burned in a furnace and through its chemical union with the oxygen of the air, the energy is liberated in the form of heat which, in turn, converts the water into steam capable of performing useful work.

Again, through the action of the sun, water is evaporated and lifted from lower levels to be deposited at higher levels in the form of rain. From these higher levels the water descends and its energy of flow is utilized in waterwheels for performing useful work.

Still another familiar instance of the indirect action of the sun's rays is the wind, which is employed for propelling ships and for driving windmills.

The direct utilization of the sun's rays for producing useful work, however, has been tried from time to time and, although proving feasible, heretofore has not been commercially successful. In most cases the cost of the necessary apparatus has been so great, in proportion to power developed, as to make successful competition with other methods of producing power impossible.

The most recent sun-power development is that invented by Frank Shuman, of Tacony, Philadelphia, who now has a plant erected at that place for testing purposes. Early in his investigations Mr. Shuman recognized that to obtain the maximum power from the sun's rays would necessitate apparatus of such complexity as to render the cost prohibitive. He therefore decided to sacrifice efficiency for cost and designed a plant which would operate at a mean between the two.

It has been calculated by scientists that, theoretically, the maximum heat obtainable from the sun's rays at the equator is about 204 B.t.u. per square foot of heat-absorbing surface. This would decrease with latitude north or south and at Philadelphia would be only about 40 per cent. of the solar constant.

With a heating surface perpendicular to the sun's rays as high as 90 per cent. of the theoretical heat may be obtained, but such a heater requires an expensive mechanism which will revolve it as the angle of the sun's rays changes. In the present case a stationary heater of the meridian type is used, and, although about 70 per cent. of the solar constant is the maximum obtainable, the construction is such as to render the cost comparatively small.

In actual tests at Philadelphia, obtained by weighing the water and taking temperatures, as high as 88 B.t.u. were absorbed per square foot of absorbing surface. From the foregoing it would appear that close to 150 B.t.u. per square foot of heating surface might be expected in the tropics. This would be equivalent to an efficiency of about 70 per cent., which compares favorably with that of an ordinary steam boiler.

The plant in its present development consists of an absorber or low-pressure boiler, a low-pressure steam engine, a condenser and auxiliaries.

The absorber, as shown in Fig. 1, is made up of a number of units each consisting essentially of a rectangular chamber for water and steam, inclined at an angle with the horizontal, and two flat mirrors for reflecting and concentrating the sun's rays. The steam and water chamber, which is of sheet iron painted black to absorb the heat, is set on a flat wooden box covered with two layers of glass with a 1-inch air space between, and a 2-inch layer of granulated cork on the under side. This is to prevent conduction and convection of heat

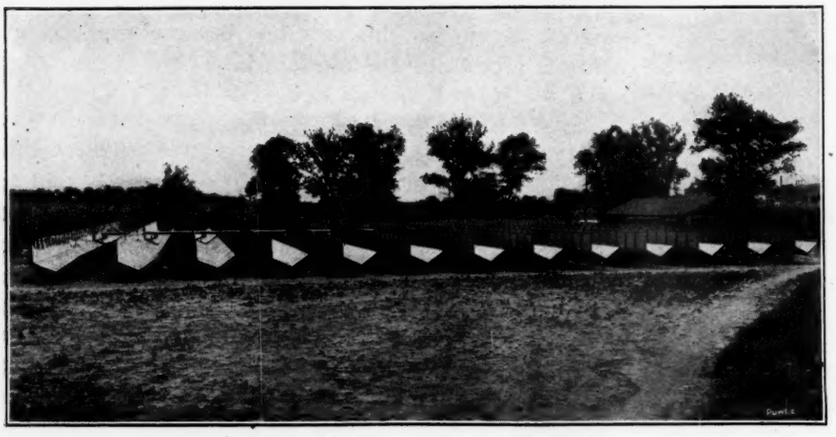


FIG. 1. GENERAL VIEW OF ABSORBERS

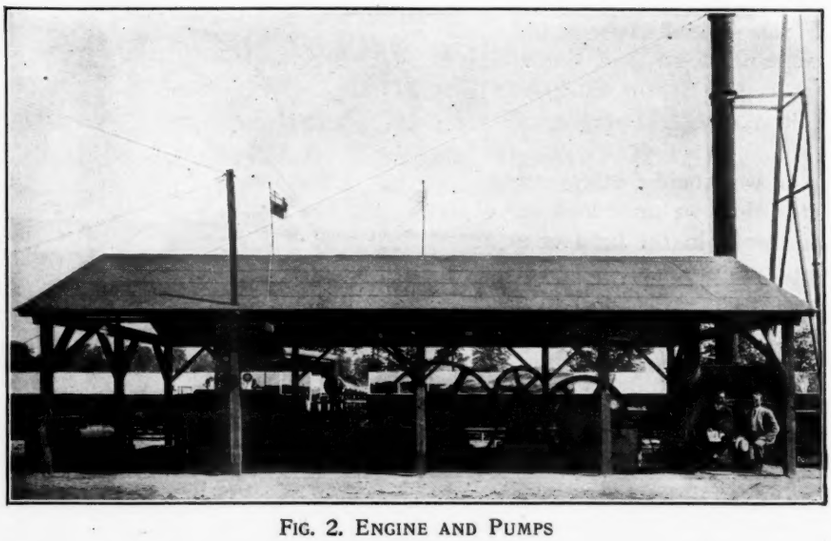


FIG. 2. ENGINE AND PUMPS

away from the absorber. It is obvious that the greater part of the heat utilized from the sun is radiant heat.

The boxes are mounted in frames and are arranged on a quadrant so that their angle with the horizontal may be altered. These adjustments are made once a week.

The feed water is led into the bottom of the water chambers and steam is taken from the top and conducted to an 8-inch main. All the absorbers are connected in multiple as regards both the steam and feed-water lines, and a connection between the two permits any condensation in the steam to drain back into the feed water. The individual connections to each absorber are lead pipe in order to afford flexibility when adjusting the angle of the frames. All the piping is insulated with hair-felt covering.

The entire system is closed and a back-pressure valve blows off when the pressure rises above atmosphere. While the temperatures attainable in the absorber are such that pressures much higher than atmosphere might be employed, such pressures would have required stronger construction which, in turn, would have made the cost much higher and rendered the device commercially impracticable. It has been found that the pressure can be regulated to a large extent by the level of the water in the absorbers and this is controlled by the feed pump.

The engine is of the single-cylinder condensing type, 36x36 inches, running at 150 revolutions per minute and especially designed for running on low-pressure steam. Separate inlet and exhaust ports are employed with large port areas and the clearance is reduced to a minimum, thus materially reducing the cylinder condensation and permitting the engine to be run with very little compression.

An ordinary surface condenser is employed and vacuums up to 28 inches have been obtained. The air pump and the circulating pump are belted to the main engine and for starting up the air pump is thrown onto a small gasolene engine; this arrangement, however, is only temporary.

The condensed steam after leaving the condenser passes through a separator, then to a settling tank which removes any entrained oil. However, should any oil clog up the small space between the plates of the absorber, these plates may be easily removed and cleaned.

The engine at present is connected through a chain drive to a reciprocating pump which delivers water to a standpipe against a head of 33 feet.

From actual tests made at Philadelphia in August, 1911, it is reported that from the absorber of 26 banks of units, each containing 22 single units and having a light absorptive area of 10,296 square feet and an actual area of 5148 square feet of steaming surface, there was developed during eight hours 4825 pounds of steam, the amount per hour varying with the time of day. The present plant is rated at 100 horsepower based upon tropical conditions, where not only is a greater percentage of the solar constant available but the temperature difference between the outside air and the steam is so much less as to reduce considerably the condensation. The maximum indicated power developed at Philadelphia has been about 33 horsepower when delivering approximately 3000 gallons of water per minute.

The estimated cost of the entire plant is $200 per horsepower. This, together with the large area covered in proportion to the small power developed, would render competition impracticable with steam- or gas-engine plants except in tropical regions where fuel is expensive. In fact, these are the conditions which the device is designed to meet and no claims are made outside of this field.

It is stated that the plant now operating at Tacony is soon to be taken down and shipped to Egypt, where it will be erected for irrigation work. It will then be working under the conditions for which it was designed and its commercial value will then be put to test.

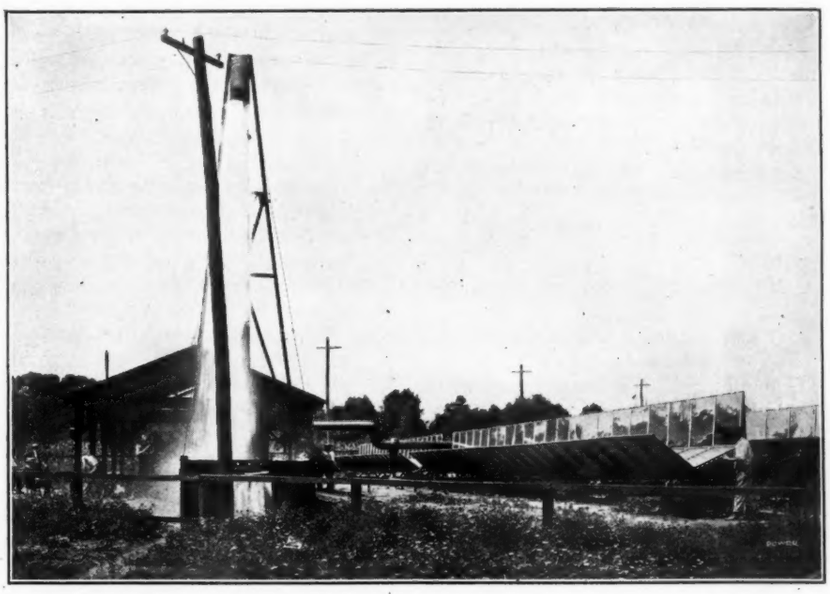


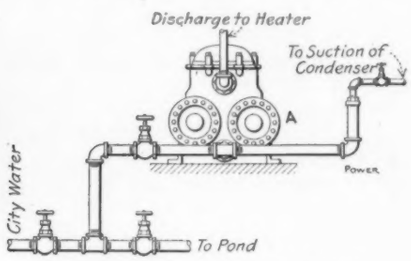
FIG. 3. PUMPING

An Emergency Pump Arrangement

The service pump which handles the feed water in a certain power plant obtains water from a river, but it can be cut out entirely and city water used if necessary.

As the pump is used continuously day and night it sometimes fails to furnish sufficient water. It also happens that occasionally the city-water supply is shut off. Should it happen that both the city supply and the pump fail at the same time the plant would be forced to shut down.

To prevent this, the chief engineer ran a connection from the top of the air chamber *A*, placed on one end of the suction pipe of the pump, to the suction pipe of the condenser, as shown in the accompanying illustration. In case the pump packing wears and fails to supply sufficient water, a valve in the connection between the air chamber and the vacuum pump is opened and the vacuum pump forms a partial vacuum in the suction pipe of the pump, thus drawing the water in such quantities that the pump is enabled to force a sufficient supply of water into the feed-water heater, from which it is taken by the boiler-feed pump.



ARRANGEMENT OF PUMP PIPING

This arrangement has saved the plant from three shutdowns since it was installed.

A small vertical boiler which was part of an artesian-well drilling outfit exploded the other day, killing a farmer by the name of Jones, who was driving by at the time. At the coroner's inquest a verdict was rendered placing the entire responsibility for the accident on the farmer, on the ground that he was the only one killed.

Centrifugal Pump Capacity and Speed

By T. W. Holloway

Calculations pertaining to the capacity and speed of centrifugal pumps, embodying problems frequently met by the practical man. In the solution of these, the fundamental working formulas commonly employed in pump design are applied.

Problems which often come up in practice and which seem to bother a great many practical men, are how to make calculations relating to the capacity and speed of centrifugal pumps. In the design of centrifugal pumps there are so many variables that it is impossible to give formulas for capacity and speed that would give accurate results for every case. In fact, extremely accurate results are not necessary in work of this kind as the capacity of a centrifugal pump may be increased slightly by a small change in speed without affecting the efficiency of the pump to any appreciable extent.

Capacity

The size of a centrifugal pump is always designated by the diameter, in inches, of the discharge opening, and, as a general rule, the pumps are so designed that the velocity of flow through the delivery opening is about 10 feet per second. With this velocity of flow the highest efficiency is usually obtained, but some centrifugal pumps that are designed for a velocity of flow of 10 feet per second through the delivery opening are capable of delivering water at a rate of 12 feet per second with but very little change in efficiency. When calculating the discharge of a centrifugal pump the discharge velocity furnished by the builders should be employed, but if this is not known a velocity of 10 feet per second should be used.

A simple approximate rule for calculating the discharge of a centrifugal pump when the size of the delivery opening is known is as follows:

Multiply the area of the delivery opening in square inches by the velocity of flow in feet per second and by 720 and divide the product by 231. The result will be the capacity in gallons per minute.

Expressing this rule as a formula,

$$Q = \frac{720\,A\,V}{231} \qquad (1)$$

in which

Q = Capacity of pump, in gallons per minute;
A = Area of delivery opening, in square inches;
V = Velocity of flow through delivery opening in feet per second.

Example: What will be the discharge of an 8-inch centrifugal pump?

Solution: Assume the velocity through the delivery opening to be 10 feet per second since it is not known. The area of the delivery opening is

$0.7854 \times 8^2 = 50.265$ *square inches*

Substituting in formula (1),

$$Q = \frac{720 \times 50.265 \times 10}{231} = 1566$$

gallons per minute

If the velocity through the delivery opening had been given as 12 feet per second, the capacity of the pump would have been about 1880 gallons per minute.

If the size of the pump is desired for a given discharge, the diameter of the delivery opening may be found by the following rule:

Multiply the desired discharge by 231 and divide the product by the velocity of flow in feet per second, by 720, and by 0.7854; then extract the square root of this result.

Expressed as a formula,

$$D = \sqrt{\frac{231\,Q}{0.7854 \times 720 \times V}} = 0.64\sqrt{\frac{Q}{V}} \qquad (2)$$

in which

D = Diameter of delivery opening in inches;
Q and V have the same meaning as in formula (1).

Example: A centrifugal pump is to handle 5000 gallons of water per minute. What size of pump should be installed?

Solution: Assuming a velocity through the delivery opening of 10 feet per second and applying formula (2),

$$D = 0.64\sqrt{\frac{5000}{10}} = 0.64 \times 22.36 =$$

14.3 *inches*

Probably a 14-inch pump would be installed.

A 14-inch centrifugal pump was recently installed to handle about 5000 gallons of water per minute under normal conditions, the capacity of the pump having been calculated by formula (1). After the pump was installed the discharge was measured by means of a rectangular weir, the nature of the basin which received the discharge being such that this could be easily done. The width of the weir used was 42 inches, and when the pump was operating under normal conditions the depth of the water measured from the bottom of the weir to the level of the water in the basin was found to be 12 inches. A practical formula for the discharge from a rectangular weir was then applied. This formula was as follows:

$$Q = 3.288\,b\sqrt{d^5} \qquad (3)$$

in which

Q = Quantity of water discharged, in cubic feet per second;
b = Breadth of weir, in feet;
d = Depth of weir, in feet.

Applying formula (3) to the case at hand,

$$Q = 3.288 \times 3\tfrac{1}{2}\sqrt{1^5} = 11.5 \text{ cubic feet per second}$$

Since there are 7.48 gallons to the cubic foot, the discharge in gallons per minute is

$$11.5 \times 7.48 \times 60 = 5161 \text{ gallons}$$

This value is very close to the calculated discharge when the velocity through the delivery opening was taken as 10 feet per second, showing that the calculated discharge agreed fairly well with the measured discharge. Of course, both methods give approximate results, but the comparison shows that the calculated discharge, on the assumption that the velocity through the delivery opening is 10 feet per second, agrees as well as can be expected with what actually happens in practice.

Speed

The speed at which a centrifugal pump should run will depend upon the design of the runner and upon the head against which the pump is required to work. Theoretically, the circumferential speed of the periphery of the runner, or, in other words, the tangential or rim speed of the runner, should be equal to the velocity that a body would have after having fallen through a distance equal to the total head; that is, the static head plus the head due to frictional resistance.

The theoretical velocity of a falling body is expressed by the formula

$$v = \sqrt{2gh}$$

in which

v = Velocity, in feet, per second;
g = Acceleration due to gravity = 32.16;
h = Hight, in feet, through which the body falls.

The velocity of the periphery of the runner expressed in feet per minute then becomes

$$V = 60 \times \sqrt{2gh} = 480\sqrt{h}$$

in which

V = Velocity in feet per minute.

Since h represents the total head, let h' represent the static head and h'' the head due to friction. Then

$$h = h' + h''$$

Now, h' is known since it is the vertical distance in feet between the water level and the point of discharge and, according to the laws governing the flow of water in pipes,

$$h'' = \frac{flv_1^2}{2gd}$$

in which

h'' = Head, in feet, due to frictional resistance;
f = Friction factor which is ordinarily taken as 0.02;
l = Length of pipe, in feet;
v_1 = Velocity of flow, in feet, per second;
g = Acceleration due to gravity = 32.16;
d = Diameter of pipe, in feet.

Substituting the value for h'',

$$h = h' + \frac{f l v_1^2}{2 g d}$$

and when substituting the value of h in the formula for V the formula becomes

$$V = 480 \sqrt{h' + \frac{f l v}{2 g d}} \qquad (4)$$

This formula may be used for finding the velocity of the periphery of the pump runner, or, in other words, the tangential or rim velocity of the runner. Having found the velocity of the runner, the number of revolutions per minute may readily be found by dividing this velocity by the circumference of the runner.

The results obtained by the method just given for finding the speed at which a centrifugal pump should run, should be considered approximate as conditions may be changed somewhat by the angle which the tip of the vanes makes with a tangent to the circumference of the runner, and by the radial velocity of the water issuing from the runner. An example will best show the method of applying the foregoing formulas for finding the speed of a centrifugal pump.

Example: An 8-inch centrifugal pump is dischargihg at the rate of 10 feet per second through a pipe 300 feet long against a head of 30 feet. If the diameter of the pump runner is 24 inches, at what speed should the pump be run?

Solution: Applying formula (4),

$h = 30$ feet;
$f = 0.02$ foot;
$l = 300$ feet;
$v_1 = 10$ feet per second;
$g = 32.16$;
$d = \frac{8}{12} = \frac{2}{3}$ foot.

Substituting,

$$V = 480 \sqrt{30 + \frac{0.02 \times 300 \times (10)^2}{2 \times 32.16 \times 0.666}} =$$

3185 *feet per minute*

The circumference of the runner is

$$2 \times 3.1416 = 6.2832 \text{ feet}$$

Therefore, the number of revolutions per minute is

$$3185 \div 6.2832 = 507,$$

or 500 approximately.

A general approximate rule which is often used in practice for finding the tangential velocity of the runner is to multiply the theoretical velocity which a body would attain in falling through a distance equal to the static head by 1.25. By this method the friction head does not enter into the calculation, the friction head being assumed to be 25 per cent. of the static head, and is taken care of by multiplying the theoretical velocity due to the static head by the constant 1.25. Expressed as a formula,

$$v = 1.25 \sqrt{2gh}$$

in which

v = Velocity, in feet, per second;
$g = 32.16$;
h = Static head, in feet, that is, the distance in feet between the supply and the point of discharge.

The tangential velocity of the runner, in feet per minute, is

$$V = 60\,v = 60 \times 1.25 \sqrt{2gh}$$

from which

$$v = 600 \sqrt{h} \qquad (5)$$

This general approximate formula gives good results in most practical cases where the discharge pipe is of usual length, but if a very long discharge pipe is used or if more accurate results are to be obtained, it is usually better to take the friction head into consideration as was done in the first case instead of using a constant, for all cases, to take care of the friction head.

Applying this general approximate formula (5) to the foregoing example,

$V = 600 \sqrt{30} = 3286$ *feet per minute*

which is the tangential velocity of the runner.

The number of revolutions per minute equals

$$\frac{3286}{2 \times 3.1416} = 523$$

It will be seen that this result obtained by the use of formula (5) differs only slightly from the result found with formula (4).

Although the exact capacity and speed of a centrifugal pump cannot be definitely determined by calculations, results which are usually accurate enough for most practical purposes can readily be obtained by the formulas given.

Experience with a Second Hand Boiler

By William F. Joy

In a Southern city, some time ago, the old "shot-gun" boiler which Jones was operating, blew up and then Jones was in the market for another boiler. He accordingly went to a second-hand dealer and negotiated for a first-class, second-hand boiler.

Now Jones had a friend named Allen, representing an insurance company, to whom he had told his troubles. Allen's advice was not to buy a second-hand boiler, without having expert opinion on it. He suggested that one of the insurance company's inspectors look over the boiler before Jones purchased it, and if it was found to be in good condition the company would be glad to insure it.

"Oh, no!" said Jones, "Smith, the second-hand dealer, and I went to school together. I have every confidence in him; I know he is on the level and he will give me a square deal."

Later Jones thought better of the advice of his friend Allen and decided to insure the boiler. When the inspector visited the plant to examine it he found it to be of an old type such as was used on towboats a generation ago, with a fore-and-aft steam drum. To get into the boiler from the top, one first had to enter the drum, then squeeze down through the neck into the top of the boiler itself. A number of braces on both heads were broken, the tubes were pitted and the sheets corroded, but the outside of the shell was nicely adorned with a thick coat of tar. Jones wondered what good the tar did, but was told that all second-hand boilers must be covered with tar to preserve them.

When the inspector saw the tar he at once became suspicious. He heated a brick and with the aid of a pair of tongs began removing the tar. This showed the shell to resemble a sieve. The boiler was guaranteed by the dealer to be safe for 110 pounds pressure. After calculating the probable strength and considering its condition, the inspector told Jones he would allow 50 pounds and no more.

This decision annoyed Jones and caused him to say, "If you don't want to insure it, there are others, and I'll get a company that will." Accordingly an inspector from another company was called in and was requested to examine the boiler. A further application of the hot-brick treatment disclosed more trouble, making matters look still worse and adding "insult to injury"; so a third inspector was tried, but with the same result.

Jones became angry when he realized that no one wanted to insure his boiler; so back he went to Smith.

"Say, Smith, I don't want that old boiler; no one will insure it. You will have to take it back, and return my money."

Jones had paid part cash and given his note for the balance. Of course, Smith could not see it that way and refused point-blank.

"That's a good boiler," said Smith, "because Kelly says so, and he knows more about boilers in a minute than those inspector chaps know in a month."

"Well, I'll sue you," replied Jones.

"Go ahead and sue," said Smith; so the controversy came to trial.

For reasons unknown to the uninitiated, Jones lost his case and was compelled to pay the costs of the suit, besides losing the amount he paid for a bond, to protect his note to the dealer, and as Jones had already paid $500 cash to bind the sale, that went too, and he had to make his note good for several hundred dollars more. All he had left was his first-class, second-hand boiler, and that was useless.

Finally the boiler was relegated to the scrap heap, and Jones bought a new boiler.

The Steam Turbine in Germany

By F. E. Junge

Description of S. M. F. turbine, which is of pure impulse type. Latest design has eleven wheels—five in the high-pressure and six in the low-pressure division. Results of tests to determine effect of shrouds covering blade tips and the effect of varying pitch of blades.

The S. M. F. turbine, built by the Sächsische Maschinen Fabrik, formerly Richard Rartmann, in Chemnitz, is of the pure multiple-stage impulse type, having from 6 to 18 runners. The original type of S. M. F. turbine, which is illustrated in Fig. 1, had the runners divided into three groups, there being two wheels in the high-pressure, three in the middle, and five in the low-pressure division. The latest type brought out by the firm, of which a front view is shown in Fig. 2, has only two groups of runners, like the Zoelly turbine, there being five wheels in the high-pressure and six wheels in the low-pressure division. The runners are made of Siemens-Martin steel and are forged in one piece with the hubs. They are finished to a polish all over to insure both quiet running and small steam friction and are mounted from both ends of the shaft toward the middle, which is larger in diameter than the ends. The dovetail blades are cut from profiled nickel-steel bars and inserted through two diametrically opposite openings of the wheel rim into the groove, being held in place by distance pieces in the ordinary manner. The long blades of the low-pressure division decrease in thickness toward the outer end, thus reducing the centrifugal force and the stress on the wheel disk. Their form and manner of attachment are illustrated in Fig. 3, which is very instructive as showing the development of the wheel and blade construction.

Originally the runners had a blade pitch of 0.55 and 0.66 inch respectively, and no shrouding was employed. Later the pitch was reduced to 0.39 and 0.47 inch respectively, and a shroud was added. Still later, the shroud was strengthened against the centrifugal force by winding a layer of nickel-steel wire around it. The shroud proper, which is of U-section, is composed of three or four segments, stiffens the blades, confines the steam in a radial direction, and reduces steam friction in the casing. The wire layer serves to connect the blades and shrouding into one rigid unit, and to guard the system against blade fracture.

The guide wheels are made of cast iron, and the guide blades of sheet steel. Where the hubs of the runners pass through the guide diaphragms they are packed by means of loose bushings, which are grooved after the manner of the labyrinth packing. These bushings are ground on the hubs, being pressed by the steam pressure against a ground and polished shoulder, which is provided on the diaphragm. This arrangement has the advantage that the bushings can partake of and yield to small movements of the shaft and hub, without harming the packing. Owing to the fact that there is no pressure difference between the two sides of the runner and that the expansion of the steam takes place in the guide diaphragm only, the play between fixed and movable parts can be kept amply large. Openings in the disks serve to make the equalization of pressure upon the two sides of the runners complete.

At the passage from the high- to the low-pressure part, in the latest construction, an especially long bushing with labyrinth packing is employed. Besides the purpose of packing, it serves as a stop and shoulder while the shaft is running through the critical speed. Live steam is fed to the first guide diaphragm through an annular channel which surrounds the casing. An overload valve serves to admit live steam from this annular channel directly to the third guide diaphragm. In the latest construction the turbine casing is divided in the horizontal as well as in the vertical center plane.

Both casing and bearings can move on the foundation frame in the axial direction, thus allowing for variations in length through heating and cooling. These

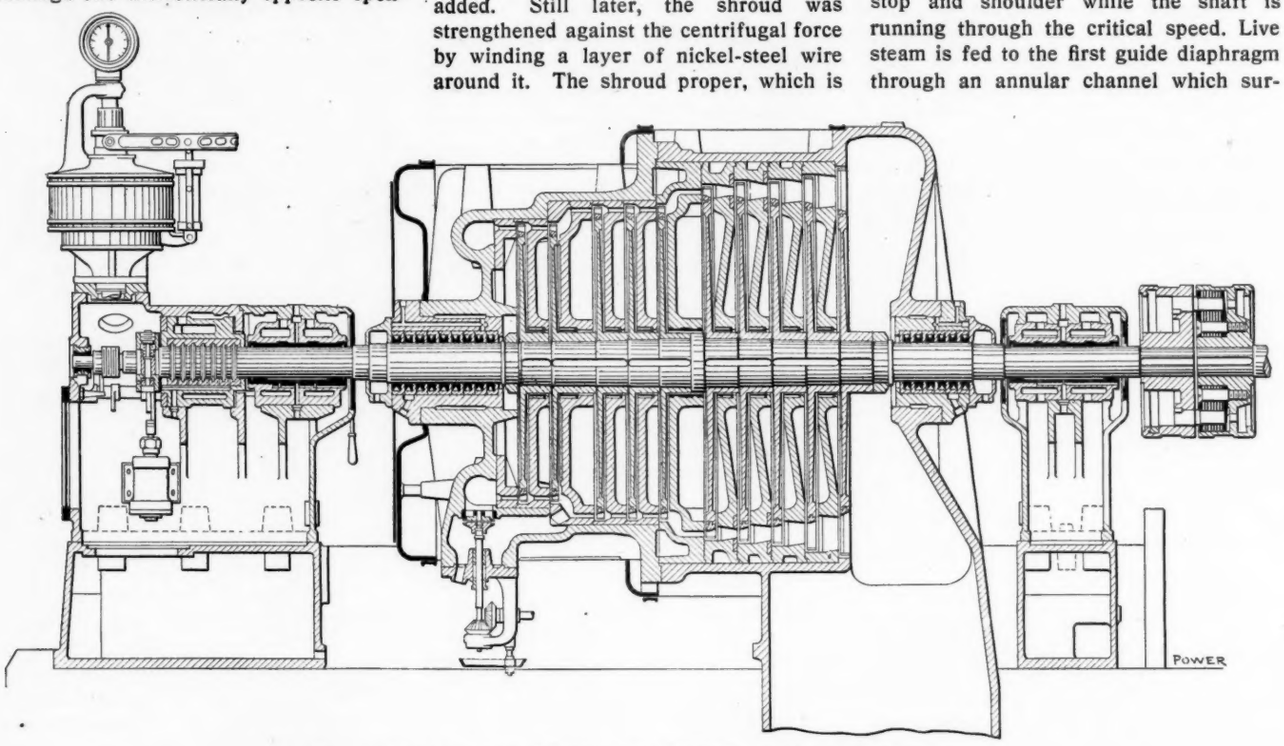


FIG. 1. LONGITUDINAL SECTION OF ORIGINAL S. M. F. TURBINE

variations are considerable, especially in the high-pressure part, where temperatures of 572 to 662 degrees Fahrenheit occur. This precaution, as well as the even distribution of material by proper design, is necessary because, if neglected, fractures are apt to occur when high superheat is employed. The two water-cooled main bearings are arranged

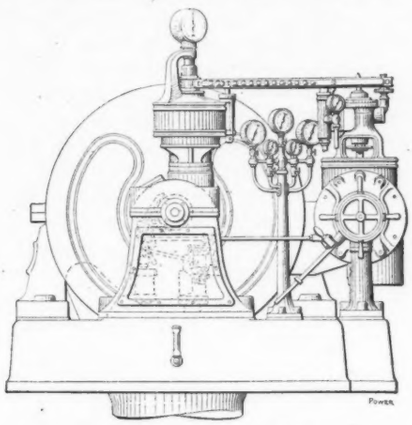


FIG. 2. HIGH-PRESSURE SIDE OF 600-HORSEPOWER S. M. F. TURBINE

separately from the casing, being mounted directly on the frame. They are lubricated by cooled oil under pressure, which is supplied by a rotary pump. In addition, there is a hand pump for starting and a steam-driven oil pump for reserve purposes. The latter is automatically switched in if the rotary pump gets out of order.

To secure the exact position of the turbine shaft in the axial direction and to counteract the inconsiderable but unavoidable axial thrust, a collar thrust bearing is provided on the high-pressure side, but outside the main bearing. From the prolongation of the shaft beyond the thrust bearing, the safety governor and the worm gear for operating the speed governor are actuated. The latter runs in an oil bath. The safety governor acts by means of springs and levers on the main steam-admission valve and can be adjusted to any speed limit. Usually it acts when the number of revolutions of the turbine surpasses the normal by 15 per cent. The oil-pressure regulator acts by first switching in the reserve oil pump when the oil pressure drops below a certain limit; and in case that the pressure drop should continue it throws the turbine out of operation. The main steam valve cannot be reopened by hand unless the normal speed and the normal oil pressure are restored.

Speed regulation is performed by means of a spring governor, the action being transmitted through a hydraulic motor which acts on the throttle valve, as shown in Fig. 2. A combined adjustable-spring oil dashpot serves to dampen any sudden fluctuations of the governor. The throttle valve and the main valve are located in a common housing, which is arranged either horizontally or vertically beside the floor stand, the arrangement depending upon the capacity of the turbine. The balanced main valve is combined with a bypass valve and is opened either by a handwheel or lever. The latter is used after sudden disengagement by the safety governor. Speed variation within predetermined limits for purposes of paralleling the generators is accomplished either by a hydraulic relay from the switchboard or by means of a handwheel provided on the turbine. Between the turbine and the generator an elastic coupling is inserted, which compensates the radial as well as the axial inaccuracies of alinement of the two units.

Special attention is devoted to the construction of the stuffing boxes, which are illustrated in Figs. 4 and 5, which show the details of the packing on the high-pressure side. Located at the inner end of the packing is a bushing *A*, equipped with labyrinth grooves. Adjoining it are carbon rings consisting of three segments which are lightly pressed around the shaft by means of helical springs. The packing in the axial direction is performed by means of a number of small spiral springs *B*, which are held in distance rings and transmit their pressure to the carbon rings by means of washers. They also compensate for the expansion of the rings through heat and permit a certain amount of sliding, according to the condition of the shaft. The circumferential helical springs have lugs engaging projections and recesses of the carbon rings, preventing the latter from revolving with the shaft. Bushing *A* and the three adjoining carbon rings are inclosed in a cast-iron casing which, at one end, is surrounded by a bipartite casing. The latter has an annular space *C*, in front of which another stuffing box is provided.

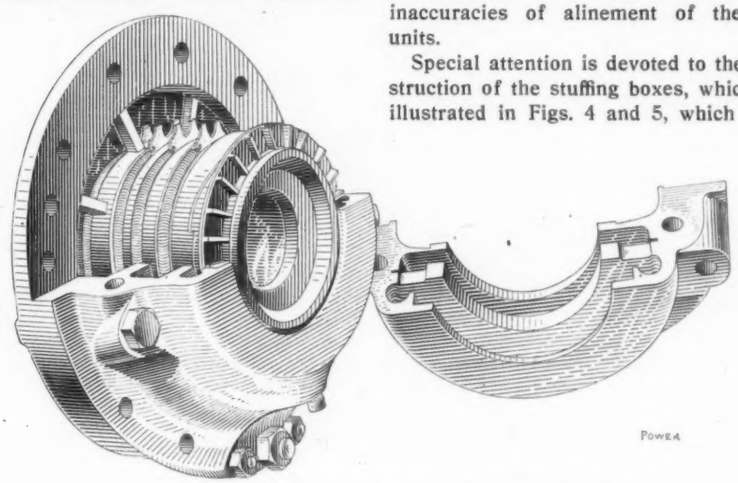


FIG. 4. STUFFING BOX FOR HIGH-PRESSURE SIDE

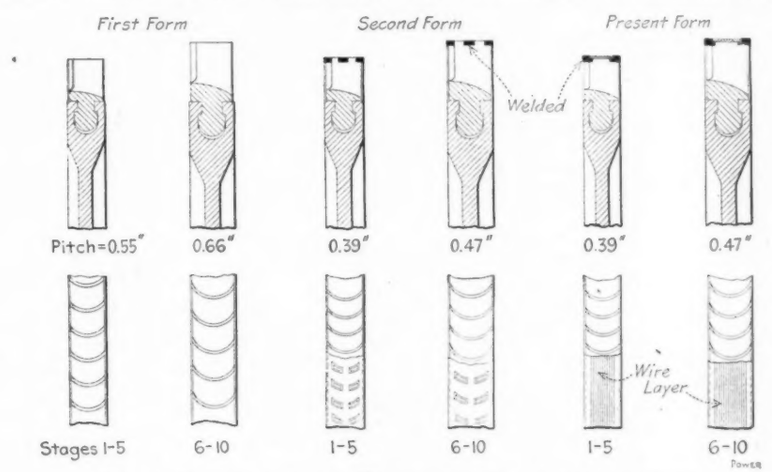


FIG. 3. DEVELOPMENT OF WHEEL AND BLADE CONSTRUCTION

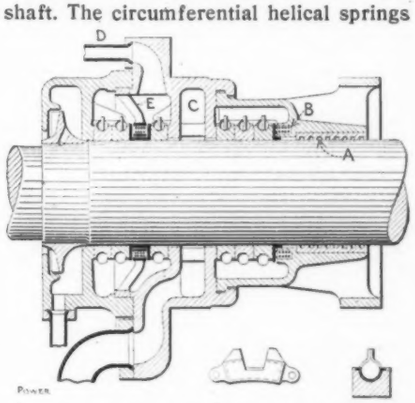


FIG. 5. DETAILS OF PACKING IN HIGH-PRESSURE STUFFING BOX

It consists of three more carbon rings, which are pressed radially around the shaft and axially against the packing shoulder provided in the space *E*. If necessary, packing steam can be admitted through the tube *D*. A propeller ring, seated on the shaft outside the packing box, prevents the leakage of steam along the shaft by aspirating air and pressing it together with the steam into the water-sealed drain pipe. The construction of the low-pressure packing ring is similar, with the difference that five carbon rings are employed.

When the turbine is running at normal load the high-pressure stuffing box has to pack against a pressure difference of five atmospheres within and one atmosphere without, and the steam entering the antechamber is conducted to the low-pressure stuffing box in order to guard it against the influx of air. In this case the antechamber, by a valve-controlled passage, is connected with the space behind the fifth runner, in which at normal loads a pressure slightly above atmospheric prevails. If the waste steam of the high-pressure stuffing box does not suffice, the required packing steam for the low-pressure side is taken from the middle stage of the turbine. When the carbon rings are new the stuffing box is tight. When the rings are worn out the influx of air into the turbine at pressures below atmospheric, as when starting, is prevented by using live steam for packing purposes, as mentioned in a previous paragraph.

A series of very interesting tests was recently made with S. M. F. turbines by Professor Josse, of the Royal Technical Institute, of Charlottenburg. The purpose of the tests was to ascertain, besides the general economic efficiency, what results attend the employment of shrouds or rings covering the blade tips in the various stages, and what are the effects on the efficiency of the turbine when the blade pitch is reduced as described and illustrated in Fig. 3. In addition, the friction of the bearings and the windage of the different stages was to be determined, and a relation established between the amount of the latter and the density of the steam. A short summary of the results of these tests follows:

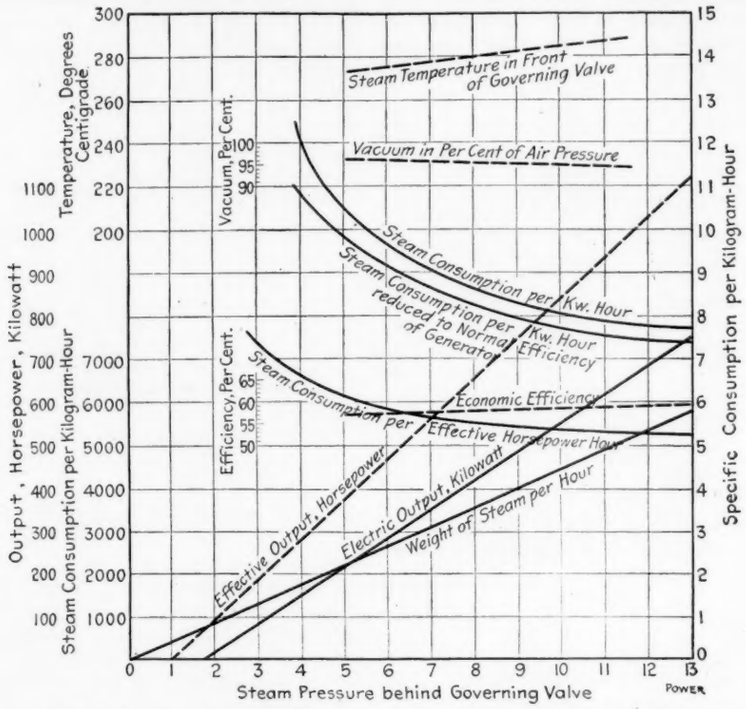

Steam Temperature in Front of Governing Valve
Vacuum in Per Cent of Air Pressure
Steam Consumption per Kw. Hour
Steam Consumption per Kw. Hour reduced to Normal Efficiency of Generator
Economic Efficiency
Steam Consumption per Effective Horsepower Hour
Effective Output, Horsepower
Electric Output, Kilowatt
Weight of Steam per Hour
Temperature, Degrees Centigrade
Vacuum, Per Cent.
Efficiency, Per Cent.
Output, Horsepower, Kilowatt
Steam Consumption per Kilogram-Hour
Specific Consumption per Kilogram-Hour
Steam Pressure behind Governing Valve
POWER

FIG. 6. RESULTS OF FIRST SERIES OF TESTS; PITCH 0.55 AND 0.63 INCH; BLADES WITHOUT SHROUDS

In the first series of tests no shrouds were employed, but a blade pitch of 0.55 and 0.66 inch respectively, was employed. In the second series shrouds were used and the blade pitch was reduced to 0.39 and 0.47 inch respectively. Otherwise the conditions of the two tests were, if not identical, yet sufficiently similar to make a comparison between the results interesting. Fig. 6 is a graphic illustration of the results of the first and Fig. 7 of the second series of tests. There are differences in condition and differences in result, the former of which refer to the load, to the temperature and the pressure of the steam, and to the electric output, 700 kilowatts in the second against 640 kilowatts in the first series; also, to the moment of inertia of the rotating parts, which increased by the change. The latter refer to the steam consumption, to the utilization of heat, and therefore to the economic efficiency; also to the losses, both internal and external, which influence the said efficiency.

Of the greatest interest is the effect of the change of construction on the general economic efficiency, which is the ratio of utilized to available heat drop. At full load the economic efficiency in the second series of tests is 61 per cent., or 2 per cent. higher than in the first series; at three-fourths load the efficiency is also 61 per cent., or 4 per cent. higher than it was at two-thirds load in the first series. At one-fourth load the efficiency is 60.5 per cent. against 57 per cent. at one-third load in the first tests. Thus by covering the blade tips and reducing the blade pitch, a considerable improvement

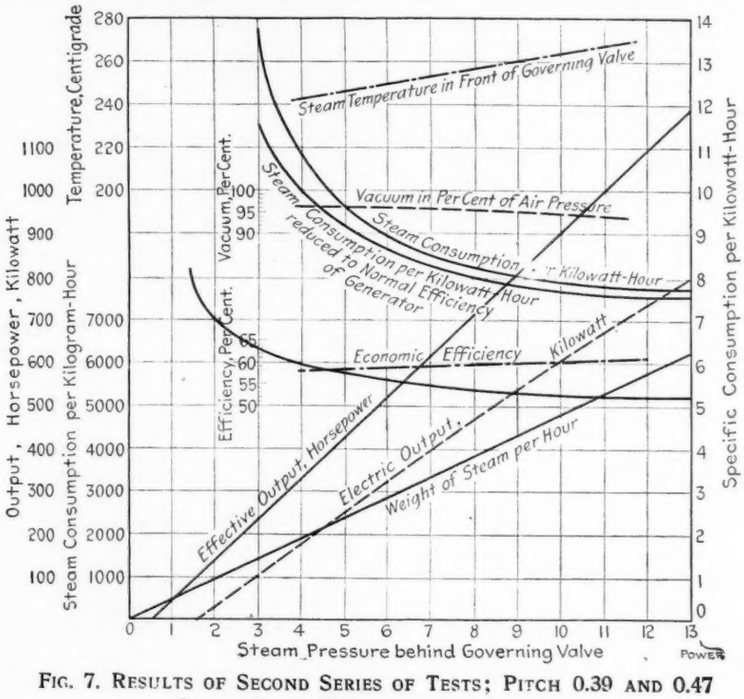


FIG. 7. RESULTS OF SECOND SERIES OF TESTS; PITCH 0.39 AND 0.47 INCH; BLADE PROVIDED WITH SHROUDS

in the utilization of heat is realized, especially at three-fourths and one-third loads. The improvement is still more remarkable if the different groups of stages *per se* are considered. Thus the economic efficiency of the high-pressure group at full load was 46.3 per cent. against 40.5 per cent., at three-fourths load, about 50 per cent. against 44 per cent. with the old construction. In the middle group the economic efficiency at full load was 65.6 per cent. against 56 per cent. formerly, an approximate rate of improvement being realized for all loads, whereas the efficiency of the low-pressure group shows a slight decrease at all loads; for example, at full load, 57.3 per cent. against 59.7 per cent.; at

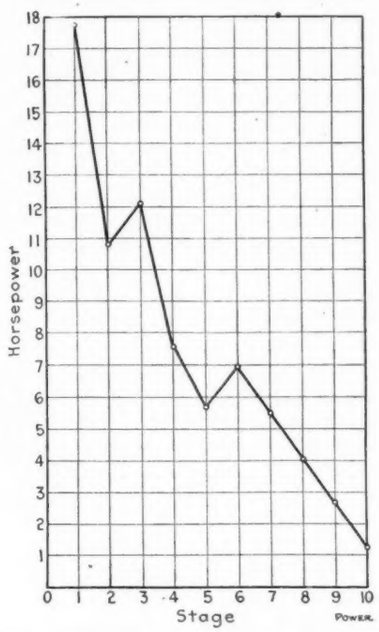


FIG. 8. FRICTION IN THE VARIOUS STAGES

three-fourths load, 51.5 per cent. against 53.7 per cent.; at one-third load, 54 per cent. against 54.8 per cent. Possibly this decrease is explainable by inaccuracies in the test. This much, however, is certain: the employment of shrouds in the high-pressure part—on account of the short hight of blades—effects very marked improvements in economy, while the low-pressure part does not materially profit by the change. Here the addition of another runner brings a probably greater advantage, owing to the high vacuum employed, than the covering of the blade tips.

Regarding the influence of the pitch, the researches of Briling—referred to in the theoretical part of these discussions—make it evident that with steam velocities of about 1300 feet per second and a width of blade of 0.97 inch, the most favorable coefficient of velocity occurs when the pitch equals the radius of the blade slope, while with an increase or decrease of the pitch the coefficient grows smaller, first inconsiderably, afterward faster. From the results attained by Briling it appears that there must be a most favorable or standard pitch for every condition; because the smaller the pitch, the better the guidance of the steam; hence the smaller, also, the losses due to eddying. On the other hand, the smaller the pitch, the greater the surface of metal exposed to the steam, and also the greater the losses due to steam friction. Since in the above tests the efficiency of the low-pressure stages was not improved either by the covering of the blade tips or by the smaller pitch, Professor Josse concludes that in the low-pressure part shrouds are superfluous and, with the increased section of the steam jet, the diminution of blade pitch has, if any, a harmful effect.

Regarding losses, it was found that the external losses were approximately the same—13.8 horsepower at 3000 revolutions per minute; that is, the friction work absorbed when the turbine is running idle, the difference of 1.1 horsepower in the second series against the amount formerly obtained, being, perhaps, explainable by the different conditions of the bearings. The internal losses, especially those due to friction and windage of the steam decreased, there being a saving of 16 horsepower in the second series. The friction work of the different groups of stages is graphically shown in Fig. 8. It is seen that the friction work in the high-pressure group is very high but decreases with decreasing density of the working medium. When the economic efficiency, as determined above, is used for calculating the steam consumption of the S. M. F. turbine under the ordinary steam conditions: temperature, 300 degrees Centigrade (597 degrees Fahrenheit); vacuum, 94 per cent.; pressure, 13 atmospheres (191 pounds absolute); output, 800 kilowatts; the result is 7.15 kilograms (15.7 pounds) per hour per kilowatt.

Smoke Abatement

In a paper read before the British Association for the Advancement of Science, Dr. J. S. Owens contended that, from the point of view of smoke emission, the present position of the manufacturer who burns bituminous coal is that entire absence of smoke is practically impossible.

The present legal standard of "black smoke in sufficient quantity to be a nuisance" is admittedly unsatisfactory, as black smoke is rarely if ever seen and blackness alone is no measure of the amount of pollution nor even of the amount of soot per ton of coal burnt. The present standard is therefore out of date. Meanwhile the public have to breathe polluted air, to suffer in health and pocket, have their buildings injured and disfigured, and their sunshine cut off.

A sound standard of maximum allowable amount of smoke should be fixed and enforced. Two questions must be answered before such a standard can be fixed: What is the best and most practicable method of measuring smoke? What is a fair fixed maximum of smoke emission?

To answer the first question we must set ourselves to find out: (1) The total quantity of soot emitted in a given time; (2) the weight of soot emitted as a percentage of fuel burnt; (3) the density or weight of soot per unit volume of flue gas; (4) the ratio only of density to a standard; (5) the color; (6) the opacity or blackness.

In deciding the method of measuring we must keep in view a fair comparison between chimney and chimney or with standard; ease of application and simplicity; reasonable accuracy; the smoke must be measured from the outside of the factory; the method must be capable of use by a single observer.

The standard suggested is one of maximum density for maximum time of emission, by which is meant the amount of soot per unit volume of flue gas. A smoke of great density would be permitted for a short time only, whereas one of less density might be permitted for a longer time.

The method of measuring the density suggested is by matching the opacity of the smoke to that of calibrated smoked glasses, each glass representing a certain density of smoke in a column of unit thickness, the final figure for comparison being obtained by dividing the density represented by the glass by the diameter of the chimney. By careful construction and the elimination of certain errors an instrument can thus be made to give a fair basis of comparison with a standard density. Doctor Owens has devised and experimented with an instrument of this type, with promising results. Certain objections will always remain to such a method of measuring, but he believes that it is only along such lines that the necessary conditions can be fulfilled.

The Alkalies act of 1906 fixes a standard maximum of $\frac{1}{3}$ grain of muriatic acid per cubic foot in smoke or noxious fumes, and it appears to the author of the paper that the time has arrived when the soot from furnaces should be dealt with on similar lines but modified to suit the location of the plant in which the furnace is installed.

One ton of refrigeration is the amount of heat absorbed by the melting of 2000 pounds of ice at 32 degrees Fahrenheit into 2000 pounds of water at 32 degrees Fahrenheit, or the amount of heat that must be extracted from 2000 pounds of water at 32 degrees Fahrenheit to reduce it to 2000 pounds of ice at 32 degrees Fahrenheit, or $2000 \times 142 = 284{,}000$ B.t.u.

Construction Costs of Power Houses

By A. E. Dixon

General discussion of the relative costs of different parts of the plant, together with actual data taken from the construction records of several well known plants.

Cost statistics, although having a certain value, often involve an element of uncertainty as to their accuracy; that is, there are some factors almost certain to be overlooked in arranging the detailed costs and summarizing them. It is true that some of the cost is due to the fact that it is impossible to construct a power plant in a day or two, the construction period usually ranging from a few months to three years or more. During this time it is inevitable that a portion of the investment be tied up and there is no income whatever from the plant, as the contracts for building and apparatus specify that certain payments must be made from time to time during the progress of the work. There are also other elements which affect the cost statistics to a greater or lesser degree.

The following data have been gathered from a variety of sources and as far as each tabulation goes it is accurate. It is interesting, however, to note the wide variations which result from local conditions and features of design:

8000-Kilowatt Plant of the West Jersey & Seashore Railroad, at Westville, N. J.

(B. F. Wood's paper before the American Institute of Electrical Engineers)

Building, stacks, coal and ash-handling machinery	$354,000.00
Equipment	640,000.00
Total	$994,000.00
Total cost per kilowatt	$110.00

8500-Kilowatt Plant of the Fort Wayne & Wabash Valley Traction Company, at Spy Run, Fort Wayne, Ind.

(Paper before American Street and Interurban Railway Engineers' Association, by J. R. Bibbins)

	Total Cost	Cost per Kilowatt
Building, including general concrete and steel work, galleries, coal bunker, smoke flue, condenser pit, coal-storage pit, etc.	$93,217	$10.97
Generating plant, including turbines, generators, exciters, cables, switchboards, transformers and ventilating ducts	259,711	30.55
Boiler plant, including boilers, superheaters, stokers, piping, pumps, heaters, setting, breechings and tanks	118,313	13.92
Condenser plant, including condensers, pumps, piping, free exhausts, water tunnels and intake screen	33,790	3.98
Coal-handling plant, including crane, crushers, motor and track	7,990	0.94
Erection, superintendence, engineering and miscellaneous	50,500	5.49
Total, excluding land and railroad siding	$563,521	$66.30

3000-Kilowatt Plant of the Youngstown & Ohio River Railroad at West Point, Ohio

(C. W. Ricker's addendum to paper by J. R. Bibbins before the American Institute of Electrical Engineers, July, 1908)

	Total Cost	Cost per Kilowatt
Building and fixtures: foundation, general excavation, concrete work, including condenser wells, overflow, ash tunnel, steel frame and building superstructure, ash-handling apparatus, coal trestle, chimney, smoke flue and crane	$64,204	$21.40
Boiler plant: six 400-horsepower water-tube boilers, settings, furnaces, pumps, heater, piping and covering	42,726	14.24
Generating plant: three 1000-kilowatt, three-phase, 25-cycle, 400-volt, turbo-generators, six 375-kilowatt, 22,000-volt, step-up transformers, duplicate exciters, switching and protective apparatus	112,764	37.59
Condenser plant: three barometric condensers with centrifugal pumps, water intake and dam, including the deepening of the channel	19,224	6.41
General expense: including the expenditures which could not be distributed easily and part of the expense of supervision	7,252	2.42
Complete	$246,170	$82.06
Substation equipment in power house; two 300-kilowatt synchronous converters with five-panel switchboard	12,600	4.20
Total	$258,770	$86.26

	30,000-Kilowatt Plant	10,000-Kilowatt Plant
Excavation and foundations, including condenser intake and outflow	$ 8.97	$ 4.89
Superstructure and steelwork	19.04	3.57
Turbo-generators and condensers	26.13	24.83
Boilers, stokers, chimneys and flues	11.11	15.75
Coal- and ash-handling equipment	1.62	1.40
Boiler-feed pumps, heaters, etc.	0.52	2.80
Piping and valves	3.17	6.58
Exciters, etc	1.01	....
Crane, air compressor, etc.	0.33	0.67
Switching equipment	6.02	1.24
Water supply	0.83	0.38
Engineering	3.90	....
Totals	$82.65	$62.11

In Koester's "Steam-Electric Power Plants" the following are given:

	Cost per Kilowatt
Boston Edison, L street plant	$125.00
Interborough, Fifty-ninth street plant, New York City	150.00
Superstructure of latter plant only	32.00

The itemized costs in the table on page 515 are also from the same book.

The cost of foundations will vary greatly and is one of the elements which local conditions affect to a greater degree than most others. The conditions vary from liquid mud to solid rock. Rock may be desirable owing to its high bearing value, but it is very expensive to excavate and the depth of excavation is frequently fixed by the local water level. The cost of the foundations will vary from 2 to 12 per cent. of the total cost per kilowatt of generating capacity. The lower costs hold where firm sand or some other readily excavated material with a high bearing value is found upon the site and the water level does not fluctuate very much. The higher costs will be found with rock excavation where the character of the rock is such that it breaks out very roughly and leaves a large excess of the excavation to be refilled with concrete. Similar high costs will be found where the underlying strata are such as to involve the use of long piles and a heavy concrete mat built within a cofferdam. In some localities it is possible to use a concrete raft, and by keeping the bearing pressures down the structure can be floated upon the soil. A raft of this kind must be so designed that it will distribute the pressure, and this calls for the use of reinforced concrete and careful proportioning to carry the heavy local loads.

Steel framing must be so proportioned as to carry the loads, and these will vary greatly. In many plants double, and in one case three decks of boilers are used, and if a heavy bunker must be supported, the steel framing will be proportionately heavy. The length of the span between columns in the boiler room will be fixed by the size of the boilers, and it is advisable to keep the column spacing below 20 feet. This spacing, or a little less, will accommodate nearly all types of boiler. Where longer spans are used the heavy girders increase the cost. The minimum amount of steel will be required when the roof trusses are supported upon the walls and carry the roof alone. This construction is objectionable as the steel work must be held back to suit the masonry and the masonry will then be delayed while the steel is being placed. This procedure will generally cost more than when the steel is so arranged that it can be erected entirely independent of the walls. The independent steel skeleton also permits the use of thin curtain walls, which results in a saving in masonry as well as in the cost of erection.

The modern double-deck power plant, with the boiler room at the bottom and the operating floor above, seems designed to get the maximum amount of power concentrated in a possible minimum floor space. This type of plant is an inversion of the original double-deck plant in which the boiler room was located above the operating floor, as at that time this type of construction was adopted to suit reciprocating engines owing to the difficulty 25 years ago of handling the heavy engine parts and erecting them on the second floor.

One of the objections made to the double-deck plant and the plant with a

heavy overhead bunker has been the use of columns passing up through the walls of the boiler settings. In one or two cases water cooling has been employed for the columns placed in the division wall between the two boilers of a battery, owing to the fear that these columns might expand unduly and irregularly from alternate cooling and heating. The coefficient of linear expansion of steel or iron is about 0.000006 per degree Fahrenheit; hence if such columns became heated to a temperature 300 degrees higher than the atmosphere they would expand 0.001800 part of their length. With a column 35 feet high, this would amount to about ¾ inch and might be very serious.

The cost of boilers and stokers ranges from 10 to 15 per cent. of the total. Brick settings may or may not be tight at the start, but they are rarely permanently tight, and this leakage is by no means unimportant. Internally fired boilers or marine settings will entirely prevent leakage into or out from the setting. Why they are not used more extensively it is difficult to say.

An engine-driven unit costs more than a turbo-generator, but the type of unit to be selected will depend upon local conditions. When a liberal supply of cooling water can be secured for the cost of pumping it is possible to maintain a high vacuum, and the turbine may be the most economical prime mover. Where cooling water is scanty and a high vacuum cannot be maintained, the reciprocating engine has many points in its favor. The turbine is inherently a high-speed proposition and is better suited to the driving of alternating-current generators than it is to driving a direct-current generator. High speeds with direct-current machinery introduce certain commutating difficulties, particularly when dealing with heavy loads.

In plants where a large portion of the exhaust steam can be utilized, a reciprocating unit may be a better paying investment than a turbine. The engine can be used as a reducing valve and operated with a low back pressure. The turbine operates better with a vacuum, and this would entail the use of live steam passed through a reducing valve, which is a rather expensive way to secure low-pressure steam.

In regard to the ground area occupied, there are a number of charts which have appeared from more or less interested sources, most of them demonstrating the economy of the turbine in this respect. It is true that the actual number of square feet occupied may be less for the turbine than for any other type of prime mover and generator, but in many cases the actual area occupied by the unit itself is not the governing feature. When it comes to a question of crowding the most generating capacity into the least possible ground area the reciprocating engine is not very far behind the turbine, even in large units. Vertical-inverted and grasshopper-type marine engines have been built in very large sizes and occupy very little floor area.

RELATIVE COSTS OF TURBINE AND ENGINE PLANTS

	Steam-turbine Plants		Steam-engine Plants	
	Per Kilowatt	Per Kilowatt	Per Kilowatt	Per Kilowatt
Excavation and foundation	$ 2.00	$ 2.50	$ 3.00	$ 5.00
Building	10.00	15.00	10.00	20.00
Tunnels	1.75	4.00	1.50	2.75
Flues and stacks	2.50	3.50	2.50	3.50
Boilers and stokers	8.50	12.00	8.50	12.00
Superheaters	2.00	2.50	1.75	2.25
Economizers	2.00	2.25	2.00	2.25
Coal- and ash-handling system	1.50	3.00	1.50	3.00
Blowers and ducts	1.00	1.50	1.00	1.50
Pumps and tanks	1.00	1.25	1.00	1.25
Piping, complete	2.25	4.50	2.50	5.00
Turbo-generators	22.00	25.00	.....	.....
Engines	.....	.....	18.00	22.00
Generators, engine type	.....	.....	10.00	12.00
Condensers, surface	5.00	8.00	.....	.....
Condensers, jet	.....	.....	3.00	5.00
Exciters	0.75	1.00	0.75	1.00
Cranes	0.25	0.50	0.25	0.50
Switchboard	2.00	3.50	2.00	3.50
Labor	1.00	2.00	1.00	2.00
Totals	$65.50	$92.00	$70.25	$104.50

The coal-handling equipment is another factor and the local conditions in some cases permit the coal to pass by gravity from the car to the bunker and thence to the fire and the ashpit and the dump. There are, however, not many cases where this scheme is feasible. The important factors are to simplify the machinery as much as possible and at the same time arrange it so that it can be operated by the fewest attendants. Each case presents its own peculiarities. This portion of the equipment will range in cost from 2 to 5 per cent. of the total.

The last point to be considered in most plants is the switch gear for controlling the electric power. In many ways this part of the equipment is the weakest link in the chain. Some of the biggest generating stations, those which would normally be supposed immune from serious interruptions, due to this portion of their equipment, have been completely put out of service for periods of time ranging from a few minutes to several hours or more. This part of the equipment will cost from 2 to 10 per cent. of the total plant cost.

Where continuity of operation is of greatest importance the double-busbar system is advisable. True, this method duplicates a part of the control apparatus and is more costly than the single-busbar system, and its entire value depends upon the price one is willing to pay to minimize possible shutdowns. The Seventy-fourth street power plant of the Manhattan Railway Company, now the Interborough Rapid Transit Company, New York, was upon one occasion tied up completely for some time by a piece of wet newspaper which landed where it could cause the greatest amount of trouble.

The barometric or jet type of condenser costs about 60 per cent. less than a surface condenser and the cost of maintenance is less. The local water-supply conditions will have to be considered in connection with this question. Where salt cooling water must be used the condenser discharge cannot be utilized for boiler feed and the large amount of water required may under such conditions make the surface condenser the cheaper. In many localities it is possible to arrange the circulating system of a surface condenser so as to take advantage of the siphon effect of a balanced water column and in this manner reduce to a minimum the amount of power required for cooling water; for after the water has been set in motion the circulating pump has only the friction head and the slight difference in head between the intake and outfall chambers to overcome.

The question of the relative advantages of steam or electrically driven auxiliaries has been threshed out a number of times. The steam from auxiliaries can be used to heat the feed water, and this is one of the most powerful arguments in favor of the steam-driven unit; in fact, within reasonable limits, the more steam used in the auxiliaries the hotter the feed water, and the relative economy of the steam auxiliaries combined with the heater will far surpass other methods of drive as all of the heat units which are not used in the auxiliary engines are returned to the boiler. Electrically driven auxiliaries, on the other hand, increase the load upon the main units, and should any serious electrical disturbances arise these vital parts of the equipment may fail at the moment when their continuous operation is absolutely necessary to keep the plant going. The only way an electrically driven auxiliary can be rendered absolutely safe is to insure for it a supply of current which does not depend upon the operation of the main generators. A special generating unit might be installed for this purpose.

The Salesman and the Engineer

By H. M. Phillips

The average engineering salesman is not sufficiently versed in the details and the operation of the article he is selling to intelligently answer the questions often asked by the prospective purchaser, and a bad impression results. Furthermore, extravagant claims are frequently made which cannot be met. Several instances of such cases are related.

The requirements for a successful engineering salesman differ in many respects from those for the man who handles real estate, dry goods, etc. Ignorance of the goods handled is one of the most startling characteristics of the engineering salesman; it is perhaps less conspicuous in men handling other lines of goods, but is probably observed by experts in those lines as well. Intentional untruthfulness does not appear to be common, but misstatements arising from ignorance are frequent.

Ten or fifteen years ago the purchaser was usually a business man, the owner, manager or even purchasing agent, with little, if any, technical knowledge. Then the salesman's ignorance of his subject did not put him at such disadvantage as it does today. Now the technical engineer is at least consulted, if not given full sway, by the better class of purchasers—those operating large plants.

The salesman should have a thorough knowledge of the goods he handles and be able to answer intelligently all possible questions regarding them. Such complete knowledge is not easily obtained—in some lines it may be impossible to give a correct answer—but an intelligent answer showing familiarity with the subject, should be at the salesman's command.

The representative of the "Old Reliable Manufacturing Company" informs the prospective purchaser that the name insures the goods as being the best on the market. To a suggestion that the price seems high, he replies: "It is better to pay for the name than for repairs." The careful purchaser is not especially anxious to do either, and he may even suggest that he has seen an equally good article made by the "Up to Date Company" at a considerably lower cost. This puts any salesman in a rather difficult position; most of them realize that it is not good policy to run down a competitor's goods and yet they are loath to acknowledge the merits of a cheaper article. If familar with the article handled he may be able to demonstrate that it has strong points other than the name; he may lay especial stress upon those points in which he knows the other article to be inferior to his own, and may even compare the two, point by point, taking care that his statements are not only correct but that their correctness can be proved in a logical manner. In some cases he may show wisdom by declining to discuss the merits or demerits of the other man's goods, confining himself to the merits of his own.

The typical salesman, however, is not equipped for a discussion of this kind; he talks generalities, and does not realize that the only logical conclusion which can be arrived at from his discourse is that the customer does not know a good article from a poor one. Upon being questioned as to the principal good features of the article, he is likely to reply: "It is made by the O. L. Company; therefore it must be the best." The purchaser may add: "The machine appears somewhat light for our work, which is unusually severe. Are you sure that it will stand the racket?" To this the sales manager replies: "It has the O. L. guarantee behind it; what more can anyone want?" "Just what is your guarantee?" you ask. "To replace free of charge any part found defective in material or workmanship within one year from date of purchase."

The guarantee, to which the salesman points with pride, will be given by any responsible manufacturer; in most instances it is of comparatively little value. Material and workmanship may be perfect, yet the machine may break down on the heavy work referred to, and loss of life may accompany the failure. In any event, the cost of repairs, except in the case of very heavy machinery, would be comparatively small and the purchaser would do the work himself, or rush the machine to the nearest properly equipped repair shop, rather than wait weeks for a new part from the factory while hours or even minutes may be worth money.

Again, the prospective purchaser may wish to procure a steam engine. The agent of the O. L. Company will guarantee the engine to deliver its rated horsepower on a steam consumption of 30 pounds per horsepower-hour at 100 pounds initial pressure. He can hardly fail to know that, but if asked how much the steam consumption will be when the engine is run for considerable periods with no load, or at one-quarter load, or what the horsepower will be when the steam pressure drops to 80 pounds, satisfactory answers will be few and far between. If the prospective customer knows the correct answers to his questions, why does he ask? Perhaps he does not know, but he can readily see that the answers he receives are absurd; he knows the O. L. Company to be a reliable firm and asks for its bid in the hope that it will furnish some information as to what the apparatus can do, or that he may be able to learn from other sources before making a purchase.

Next comes the man representing a firm whose reputation is yet to be established; his strong point is the guarantee which is much broader than that usually offered, so broad, in fact, as to excite suspicion. In some cases there will be loopholes for escape, but frequently an exceedingly rigid contract will be offered. The apparatus may be returned at the option of the purchaser at any time within three months from the date of delivery, no payment being required before the expiration of the three months. It is claimed that the apparatus will do the work at least 10 per cent. cheaper than by the purchaser's present method. If it has to do with the power plant, a 10 per cent. saving in fuel (a very popular figure) is guaranteed; failing to meet guarantees, the apparatus will be removed and everything restored to its former condition without cost to the owner of the plant. How can the engineer decline such a liberal offer? He talks with the salesman and finds that the latter is ignorant of the conditions under which the apparatus is to be used and knows but little of the theory and operation of the apparatus itself; the strong point is the guarantee. But unless the engineer can be shown some logical reason why the apparatus will give satisfaction he will not purchase it; he is more afraid of trouble and delay in the operation of the plant than of the loss of a few dollars, and no one will offer a contract which will fully recompense him for possible trouble and delay. He does not wish to try experiments which he considers doubtful; it is his business to know beforehand whether the apparatus will be successful, and the installation of an unserviceable device, even though attended with no financial loss, does not speak well for his ability.

Another point worth mentioning is that testimonials on power apparatus are about as trustworthy as those on patent medicines, although many of the latter are doubtless written in entire good faith. What may apparently give satisfaction in one plant under certain conditions will be entirely unsuited to another plant where different conditions exist.

To further illustrate the salesman's ignorance of rudimentary principles, the following examples, taken for the most part from the writer's personal experience, are given: A prominent dealer in electrical supplies made a bid on some insulated copper wire and the figure was much higher than that offered by several competitors. He stated that it would be economy to give him the order as he used "Lake Superior" copper only, which costs more than the other kinds but is cheaper in the end because it has greater conductivity and therefore less of it is needed to carry a given current. He was not certain just how much greater the conductivity of his copper was than that of the others, but thought it was about 30 per cent. Could this man have been ignorant of the fact that in wire specifications a conductivity of 98 per cent. is almost universally required and that this requirement is so easily met that an actual test is seldom made? Some wire is slightly better than the standard and shows 101 or 102 per cent., while in rare instances it might drop to 97 or 96 per cent. but one would not be likely to find copper wire on the market which does not lie between these values. Incredible as it may appear, this statement was made by the head of the firm to a man whom he knew to be an electrical engineer and who therefore could not be supposed to be ignorant of the properties of copper wire. If this man had claimed superior insulating material to account for the higher price it would have been more difficult to deny his claim.

A salesman of a large electric company visited a customer who already appeared to have formed a favorable opinion of its transformers. In the course of conversation the customer remarked: "I have been told that there is more hysteresis in your transformers than in any others on the market; is that true?" For a moment the salesman was dazed, but he soon recovered his self-possession and replied: "Yes, sir, we spare no expense to make ours the best on the market, but you will find that they cost no more than many inferior makes." Telling his experience on his return to the factory he remarked: "That fellow nearly had me, but I pulled out all right; say, what is hysteresis, anyhow?" He was informed that hysteresis is a serious loss of energy which occurs in all transformers but is greatest in those using an insufficient amount or an inferior quality of steel.

Another salesman encountered a customer as deficient in electrical knowledge as himself; one alternating-current dynamo had already been purchased and had given excellent satisfaction. As the load had increased, another dynamo similar to the first was desired to help supply current to the same wires. The customer, however, desired to use a different type of engine for the second machine and to run it at a speed about 12 per cent. greater than that of the first. He asked the salesman if that would make any difference. The salesman assured him that it would not and took the order. The company's engineers were fortunate enough to learn of the proposed conditions before shipment was made and averted trouble. There was some trouble with the customer, to be sure; but what if he had received the machine and had attempted to operate it?

A certain factory in New York City has a large, well equipped and well handled power plant. To this plant come the 10 per cent. men, and others. The man with a damper regulator, an excellent mechanism which really might save 10 per cent. in many plants but would be useless under the operating conditions of this one, does not stop to find out what the conditions are but is perfectly willing to make his guarantee. Grate bars, chemicals for sprinkling the coal, cleaning devices for the boiler, chemicals for preventing scale in the boilers, ball bearings for the shafting, compounds to prevent the slipping of belts, patent lubricants; all are offered with the guarantee of a large saving in fuel, generally 10 per cent., and no inquiry as to the operating conditions. The engineer of this plant recently remarked that if he were to adopt all the devices that are offered he would have coal to sell, for he would surely save much more than he is now using.

An interesting exception to the general rule was found in the man who examined the blower system of a small plant and was anxious to replace it by a more efficient one; one that would save a large amount of power. As a modest man, he did not like to say just how much would be saved, but after some urging he stated that it should be between 50 and 60 horsepower. It was conceeded that this would be doing very well, as the system which he examined was using only 30 horsepower. Why did he not follow the example of the others and give a percentage?

One company, through sad experience, has found it best to issue strict orders to its salesmen to forward all engineering questions to the factory. This may be safe in a way but the customer does not like to wait a week, or possibly several, for the answer to some simple question. Few people like to deal with a man who does not know his business, and the salesman with these instructions must tacitly admit the fact whenever a question is asked.

Another recruits its sales force from young men who have taken a long apprenticeship course at the plant and have been actively engaged in the manufacturing of the articles they are to sell. This is good, but not complete; the education is largely that of a mechanic and too narrow. The man, comparatively young, can tell just how the thing is made, which is good; but he knows comparatively little of the conditions governing its design and under which it will be used after it leaves the plant. Manufacturing conditions change rapidly, and unless he is careful to keep his laboriously acquired knowledge uptodate it will be of little use. The time spent in preparation seems hardly commensurate with the result.

Others engage such salesmen as they consider desirable and give them from two or three weeks to as many months at the factory to learn the business. The salesman himself, however, generally considers that keeping a man of his caliber from active work for this length of time is time and money wasted, which appears to be the case in many instances, although not in the sense intended by the salesman. The man is self-satisfied from the start; he does not want to become an engineer, he wants to sell.

The agent whom the purchasing engineer longs for but seldom has the pleasure of meeting is the man who is familiar with the mechanical construction of his goods, with their operation under the varying conditions found in actual practice and with the general theory governing both. A man with a mind which through education and experience will readily grasp such new problems as the purchaser may present; with the faculty of expressing his views clearly and concisely and of sticking to the subject at hand, will not guarantee a machine to do the work before he knows what the work is to be. After learning just how a result is accomplished with the machinery already installed, he may guarantee a saving of 10 per cent. in fuel or labor, but he will not do it blindly; moreover, he will be able to show the engineer just how and why the saving is to be accomplished.

As has already been stated, not much confidence is placed in a guarantee alone, and the salesman who can show how and why will hardly need to offer one. Instead of 10 the saving may be 1 per cent.; the purchaser may know that it can never be detected on the accounts but he is nevertheless convinced that the apparatus will accomplish it as it has been proved to him that it will. A saving of 1 per cent. on the fuel bill of even a small plant is no small item, and the same may be said of labor where a considerable number of hands are employed.

A pleasing personality, tact, fluency, perseverance, an effective entrance and exit, a knowledge of the psychological moment, are, of course, desirable qualities in all salesmen, but a full equipment of these lines will in many cases be counteracted by an insufficient knowledge of the subject on which he is speaking. The buyer has in many cases learned to steel himself against the former qualifications, even to regard them with suspicion, but the latter takes him by surprise.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Why the Electric Drive Has Not Always Given Satisfaction

By Henry D. Jackson

During the past fifteen years I have had opportunities to investigate power-plant installations, particularly those connected with factories, and have had an excellent opportunity to see why the electric drive in many cases has not proved satisfactory. The causes may be divided into three distinct classes: First, the motors; second, the wiring; third, the cost of power.

Motors

The principal trouble due to the motors has been the use of very high-speed machines, with the main object of reducing first cost. This has led to the necessity of very large pulley ratios or special methods of drive, such as chain or gear, none of which has worked out satisfactorily from the operating standpoint. The belt drive, properly installed, proves more satisfactory and economical than either gears or chains, besides being very much more quiet and flexible when changes of speed are required.

Most establishments are more or less limited either in head room or space between shafts, so that the diameter of the driven pulley is limited, as is also the center-to-center distance between the motor and the line shaft, with the result that with moderate-speed shafting, the driving pulley on the motor is frequently very small, so that with the large pulley ratio and short distance between centers the arc of contact on the driving pulley is so small that the drive cannot be operated unless the belt be exceedingly tight. This brings about a great deal of trouble with motor bearings and excessive friction, both on motor and line shaft, particularly the latter, as it frequently happens that the line shafts are so light that they are somewhat deflected. In addition to this there is frequently a great deal of trouble due to belt slippage, particularly on those machines where the load is fluctuating, making the operation of the machines very uneven, and there is also trouble owing to the high starting torque of the motors and the inertia of the shafting or the machinery, which results in the small pulleys slipping in the belts, causing burning or throwing the belts off the pulleys. The life of the belts under such circumstances is very short; they become either badly stretched or "burned out" in a comparatively short time, entailing considerable expense for replacements and the loss of one of the principal advantages of the electric drive, which is uniformity of speed.

It might be said with a grain of truth that the same general features are found in many belt-driven plants, namely, small pulleys, too narrow belts, short center distances and light shafting; but the conditions are not nearly so bad in most cases as those frequently found where electric motors have been installed with the principal idea of saving in first cost, although I have found a number of plants where the loss in speed due to belt slippage has been in the neighborhood of 25 per cent. There also are cases where the wrong types of motors have been installed, such as the squirrel-cage type where very high starting torque is required, or the slip-ring type where very high starting torque is not required, and where alternating-current motors have been used when direct current would have been far more satisfactory. Each type of motor and each condition of furnishing power has its application, but no one is universal.

Wiring

The question of wiring reduces itself very largely to the proper voltage for distribution. In many plants the distances over which power may be transmitted may be considerable; and if alternating current is used, which is apparently considered the most satisfactory, although there is no real reason for it—the voltage is of very considerable importance, as, with large powers to be transmitted at low voltage, the size of the wire and the relation of the wires to one another are matters of great importance as is also the method of installation. For example, if three-phase transmission is used, it is of vital importance that the three wires should run in the same conduit, especially if metal conduit is used; and if, owing to any special conditions, lead-covered wire is necessary, the three wires should be inclosed under the same lead covering. This is to avoid inductive effects. If large conductors are used, it is exceedingly important that they be located very close together and preferably in one cable, as the mutual induction between the wires themselves has a very bad effect upon the regulation of the circuit.

The bad effect of running a number of single-conductor cables in lead covers was particularly marked in one case which came under my observation. There were six cables in a circuit approximately 1000 feet long; each cable was of 500,000 circular mils section and the six were separated approximately 6 inches, with no attempt to arrange them so as to avoid inductive effects. The voltage drop over these cables, with direct current, would be approximately 2.5 volts, but the actual drop (with the alternating current) during average load was considerably over 55 volts, resulting in a very marked effect on the speed of the motors which were connected to the far end. The use of a three-phase cable of 500,000 circular mils in each conductor would have caused a voltage drop of only 5.5 volts with the same current.

The same reasoning holds true in two-phase work, although it is not necessary to inclose all four wires under the same covering. The pairs composing each phase, however, should be inclosed either in the same conduit or same lead sheath. If a large number of circuits are to be run, it is particularly advisable to use three-phase cable for three-phase circuits and two-conductor cable for two-phase circuits in order to prevent induction between the wires.

Since the torque of an alternating-current motor varies with the square of the voltage, it is evident that the power delivered is seriously affected if the line conductors are not arranged so as to prevent or minimize induction in them and thereby keep down the voltage drop.

For variable-speed motors, direct current is far more satisfactory than alternating, and with the use of three-wire generators and balancers, wide ranges of speed can be secured at a moderate installation cost.

Cost of Power

A frequent cause of dissatisfaction with electric drive is the cost of central-station service. I have found that in the average plant where electricity is purchased the cost has been much greater than the owners anticipated. This has been due to two causes: First, the de

sire of the company supplying the power to have the motor installation cost the owners as little as possible, in order to induce them to adopt it; this incites them to recommend high-speed motors, with the consequent troubles already mentioned. Second, because the cost of the power supply has been far greater than was anticipated. This latter has been true largely owing to a mistaken idea on the part of the supply company as to how much power had been costing the plant owner, and also to the plant owner not knowing what his power was actually costing him.

When the electric drive was installed, it cost a considerable sum of money, and naturally the interest, maintenance and depreciation on the installation are charged up as power cost. In addition to this, there is a charge by the power company designated the "service charge"; that is, a charge based on the total horsepower of motors installed, this being fixed regardless of the electrical power used. For a plant operating at full capacity, this is a very small item and is not serious; if, however, the plant is partly shut down or operating on a light load, the service charge amounts to a good deal and is a very considerable sum per unit of manufactured product. Besides this there is usually a charge based on the maximum demand, that is to say, a charge for a certain number of hours per month based upon the power used during a stated period at any time during the month, and anything beyond this is charged at a very much lower rate. This frequently works a hardship, for it may be that during a very few days out of each month the plant is operating at full load, with a large maximum demand. During the rest of the month it may be operating at light load, so that the power cost per month based on the maximum demand is large, although the amount of power used may be small compared to those months where the plant is operating continuously at full load; and the total charge per unit of output would be much greater. These items are usually entirely lost sight of during the talk with the central-station man, and the impression is gained that the cost per kilowatt-hour will be small or will be whatever may be his minimum-demand charge. The central-station man as a rule emphasizes the cost of power as shown by his minimum rate and not his maximum, so that the impression gained by the purchaser is that all of the power will be paid for at the minimum rate. A number of plant owners have found that their total power demand has been so small that they never reach the minimum-demand rate, with the result that their power bill is double or treble what they had expected; in addition to this they have to pay for the heating of their buildings which formerly, to all intents and purposes, they had obtained for nothing.

With purchased power, it is, therefore, advisable to investigate very carefully into the wording of a contract, study carefully the maximum demand, the service charge and other phrases of the contract as to what they mean, and add to the estimate of power cost what it will cost for heat, since when power is generated by steam, a large portion of the heat at any rate can be obtained from the exhaust of the engine.

Where the owner installed his own generating plant it has not been uncommon to find that alternating-current generators have been put in where direct current would have been far more satisfactory, both as regards first cost and operating cost; also, that the power factor of the alternating-current plant had not been seriously considered and, consequently, the generator was not sufficiently large for the purpose and the regulation was exceedingly poor, resulting in great variation in speed of the machinery—a result which is directly opposite to what should naturally be expected from the electric drive and gives rise to much dissatisfaction among the employees as well as causing a reduction in the output of the machinery. Belted units are frequently found installed with altogether too short belt centers, resulting in a great deal of trouble with the belts, besides increasing the losses; and the type of engine is not always satisfactory, a high-speed slide-valve engine of very poor steam economy frequently being found, which though cheap in first cost was very expensive in operating cost, particularly during the summer months when steam was not required for heating.

In other words, the principal reasons why the electric drives have in many cases not proved satisfactory are a lack of thorough investigation by the owners into the power conditions, a lack of knowledge of what could or could not be done in their plants, or either the absence of engineering advice or unfortunate selections of consulting engineers.

A Switchboard Suggestion

By A. E. Dixon

In many plants the rheostats or controllers are operated from the front of the switchboard by means of handwheels, the connection from the handwheel spindle to the controller spindle being made by sprocket wheels and a chain. It is a good plan to inclose the sprocket and chain in a light housing of wood or some other insulating material adapted for the purpose. This housing will prevent any danger of the chain coming in contact with a live portion of the circuits behind the board, should it accidentally part. It is not very much trouble to apply the housing and it may save a shutdown of the unexpected variety, accompanied by fireworks, or a dangerous and perhaps fatal shock from the handwheel spindle.

Similar means can be advantageously used for inclosing the operating levers of high-tension oil switches, etc., or catch hooks should be provided to prevent the rods from falling if a pin drops out.

Electric Drive for Textile Mills

By W. H. Booth

It is doubtful whether electrical driving has yet shown any advantage, when applied to a new factory, as compared with a modern rope-driven one. A cotton mill is, of course, the last place for electrical driving to show results, for there is so little machine-driven shafting that it is not probable that the abolition of shafting can compensate for the miter-toothed gearing and electrical distribution losses. But there is one thing electricity can do which cannot so easily be done by mechanical means; the speed of the ring spinning frames can be maintained at a maximum proper to the fullness of the bobbin and the output can be increased. This is a strong point in favor of the direct driving of each ring frame by its own motor as against group driving.

There have been some unfortunate examples of electrical driving and many claims for economy and improved turning that had no basis in fact, or rather the comparisons were wrongly drawn, for it was obviously absurd to compare the driving of an old factory forty or fifty years old with the same factory when driven electrically from a modern quick-running engine. An instance came under my observation where a man placed a ring frame in the cellar of his old mill and drove it by belt from a pair of old beam engines running at 40 revolutions per minute, badly out of balance, and with a light flywheel. The frame was next driven electrically from an engine with three cranks instead of two, at a speed of 125 instead of 40, and, of course, with many times the flywheel effect, and the spinning frame showed a better output. But the increased production of the frame per spindle was fairly well counterbalanced by the reduced number of spindles necessary to allow for the space at the frame end occupied by the motor. Advocates of electricity should pay attention to the improvements that electricity can effect which are beyond the power of mechanical means, for it is in such special directions that electricity must justify itself.

Obviously it is no comparison to say that there are electrically driven mills in America or in Italy when such electricity is water-generated. So there might be in England if there were any waterfalls. There are the equivalent of waterfalls in the shape of blast furnaces pouring to waste the gas that would produce a million horsepower, and against electrical driving from water or waste gas

there is no argument unless a certain recent Italian practice be accepted. There electricity will not be acepted if it can be avoided. More direct methods are used, for little water turbines are built into the ends of the spinning frames and driven direct by high-pressure water brought into the factory, thus avoiding the heavy cost of dynamos and motors. Such a system is not perhaps possible at a very long distance from the waterfall, but it is one solution of the mill-driving problem that shows us that we cannot or must not dogmatize in these matters.

Selecting the Right Motor for the Job

BY FRANK WILLISTON

In small plants, it is generally the custom for the "old man" to come to the engineer for advice regarding the proper motor for any given job. Hasty conclusions and approximations will go for a while, especially in alternating-current work, because the modern induction motor is credited with being able to do almost anything. But later on when the factory has grown, the "old man" will call in an "expert" who will criticize the entire layout, justly, by using a few simple rules which the engineer could have applied himself in the first place.

My experience has been that next to the errors in size, which are never very large on the part of the engineer who uses his steam indicator or moves around an old motor for a tryout, the greatest errors in judgment come in the selection of the speed of the motor. A recent case in hand illustrates the wide range of speeds from which the purchaser is required to choose the best. An overhead shaft with a load of 5 horsepower at 500 revolutions per minute required a motor drive. The various drives possible are as specified in the accompanying table.

Type	Motor R.P.M.	Distance between Centers	Cost of Motor	Cost of Connection	Total Cost
Direct connected	514	0	$177.00	$ 1.00	$178.00
Chain drive	900	3 feet	130.00	64.50	194.50
Belt drive	1200	6 feet	97.20	11.50	108.70
Belt drive	1800	9 feet	64.00	13.00	77.00

The problem started with the elimination of those drives which are not advisable owing to weight (in the case of the slow-speed motor) or the long distance required between centers (the 1800-revolutions per minute drive). Both were eliminated in this case. The next decision, between the two medium-speed drives, was decided in favor of the one at 1200 revolutions per minute on the basis of first cost and the fact that the inclosed chain drive would not bring in any added financial return in this case.

In cases similar to the foregoing it is well to remember also that the higher-speed motors give higher efficiencies and better power factors as well as lower first cost.

Another consideration is the selection of speeds which are standard for motors carried in stock or easily turned out by the manufacturer. A brother engineer recently experienced considerable delay and loss by insisting on buying 15-horsepower motors to run at 1800 revolutions per minute instead of the standard speed of 1200 revolutions per minute, though the motors do not differ much in cost.

Whatever combination is selected, the pulley on the motor should be of the standard diameter selected by the manufacturer, as better belt speeds and ultimate savings when changes or replacements are made will invariably follow.

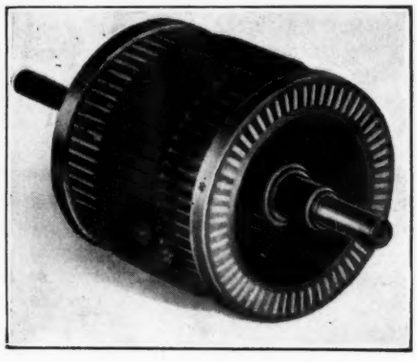
LETTERS

Preventing Rotor Bars from Loosening

Mr. Fuetterer's letter in the September 5 issue of POWER, on the trouble he has had from the loosening of the rotor bars of squirrel-cage motors, interested me because I have experienced this trouble in several types of motors that have come under my charge. The remedy that Mr. Fuetterer suggests, of bolting the bars to the end rings, is not always successful because the heat that is generated in the bars will cause the bolts to expand and allow unsatisfactory contact between the bars and the short-circuiting rings. The ill effects of this loose contact are much aggravated when the motor is in operation, because the centrifugal force in the bars tends to throw them away from the end rings. I have reason to believe that the capacity of many an induction motor is greatly cut down due to the fact that imperfect or even open circuits develop when the motor is heated up and in operation. These defects never show up when the motor is cold and stationary; therefore they are exceptionally hard to locate. I have seen induction motors in which spring washers are put under the bolt heads and on top of the rotor bars, but this arrangement does not seem to serve the purpose as the temper of the washers is soon drawn and centrifugal force again comes into play and causes the bars to break contact with the end rings.

Upon taking one of my motors apart recently, I was much interested in the construction used in the rotor. Accompanying this letter is a photograph of this construction which, however, does not show the details very clearly. In this motor, the rotor bars seem to be set in slots milled in the end rings and heavy copper shrouding rings are shrunk around the outside of the end rings after the rotor bars are in place. I have frequently tested this construction when the motor was hot and the outside shrouding rings always seemed to be perfectly tight on both the rotor bars and the main rings.

This construction seems to be exactly along the lines that Mr. Fuetterer has suggested for remedying the troubles he has experienced with loose contacts, and I thought it might interest other readers of POWER.



PERMANENTLY TIGHT ROTOR BARS

SOL SIEGEL.

New York.

Mr. Altman's Displaced Brush Holder

In reply to the letter of Edgar Altman, in the August 22 number of POWER, inquiring as to what caused the displacement of one of the brushes on a 35-kilowatt machine now used as a motor, I should say that the screw that holds the clamp collar to the stud jarred loose and the pressure of the spring forcing the brush against the commutator threw the brush over to the position indicated by the diagram.

HERBERT HILL.

Middle Falls, N. Y.

An Australian invention to overcome corrosion and pitting in metals, especially boilers, due to electrochemical action of the impurities in water appears to have met with success in Sydney. It introduces, by means of dynamos, weak electrical currents through the metals intended to be protected, thus neutralizing the galvanic action of the corrosive substances contained in the water. The process was recently tested at Melbourne University on metals immersed singly and in connected pairs in sea water, both hot and cold, and in dilute acids. It is reported that all hurtful galvanic action was suspended by a small expenditure of electrical energy.

Gas Power Department

The Diesel Oil Engine*

By Charles Day

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

The great difficulty most buyers of power-plant machinery find is in securing reliable figures of power costs from people engaged in trade, except in the case of electric-supply stations. The writer does not know of any body of large power users who systematically prepare accounts showing their power costs on a uniform basis, and publish them. This practice in connection with electric-supply stations fortunately does give an independent and authoritative basis, from which valuable deductions can be made. The figures published in the *Electrical Times* cover practically almost all the supply stations in Great Britain, and this information combined with information obtained direct from station engineers has enabled the author to determine the average results obtained in such stations. With different types of plant these averages for stations having a plant capacity not exceeding 1000 horsepower, are as stated in Table 1.

TABLE 1. AVERAGE COST PER KILOWATT-HOUR SOLD

Type of Engine	Fuel	Lubricating Oil, Waste, Stores, and Water	Wages	Repairs and Maintenance	Total Operating Costs, Pence	Load Factor
Steam	0.45	0.06	0.25	0.26	1.02	14.7
Gas	0.43	0.09	0.28	0.24	1.04	15.3
Diesel	0.23	0.04	0.19	0.07	0.53	14.3

The limit of 1000 horsepower was fixed owing to there being as yet no large electricity-supply stations equipped solely with Diesel engine or gas engines. Of course, better results are obtained when driving machinery which gives a better load factor, but the causes which produce loss are, as a rule, the same, though modified in extent. The general conclusion formed from a study of electricity stations holds good for the great majority of power users, though perhaps not applicable to some special trades, where engines can be run continuously on almost uniform loads. It is also necessary to point out that the figures include some items which should not strictly be charged against the power plant. For instance, the wages items include figures for men working on cables, street lamps, and in substations, and the repairs items include repairs to such parts. Also it is necessary to mention that the figures give the costs per unit of energy sold, not per unit generated.

*Extracts from a paper read before Section G of the British Association at Portsmouth.

From the averages it is clear that a substantial gain is obtained by the adoption of Diesel engines as against either gas or steam engines, the figures being beyond doubt substantially accurate. It is also noticeable that the gain is not only on fuel consumption, but is practically in the same proportion on the other items of expenditure.

The great saving shown by these average figures is confirmed by repeated experiences of the author. In many cases, although the figures guaranteed with Diesel engines have been no better than figures previously guaranteed and obtained on tests, with existing steam and gas engines, the Diesel engines have shown over extended periods a saving of 50 and 60 per cent., and in some cases an even greater percentage, the result being due to the fact that the Diesel engine's average working results were very much nearer to the guaranteed figures than with gas or steam engines, combined with the fact that the relatively high cost of working at light loads with gas or steam had not been sufficiently taken into account when considering the guaranteed figures.

When going through cost records to prepare the average figures previously given, the author noticed very wide differences of cost per unit, particularly in the case of the steam plant. He therefore had the average cost calculated for steam stations of different capacity, and as the results are interesting, they are given separately in Table 2.

TABLE 2. AVERAGE OPERATING COST PER KILOWATT-HOUR SOLD, FOR STEAM STATIONS OF DIFFERENT SIZES

Station Capacity not Exceeding	Fuel	Lubricating Oil, Waste, Water and Stores	Wages	Repairs and Maintenance	Total, Pence	Load Factor
250 kilowatts	0.63	0.09	0.35	0.36	1.43	13.2
500 kilowatts	0.56	0.06	0.27	0.29	1.18	13.3
750 kilowatts	0.43	0.05	0.23	0.24	0.95	15.4
1,000 kilowatts	0.40	0.05	0.23	0.21	0.89	16.8
1,500 kilowatts	0.42	0.04	0.17	0.18	0.81	16.9
2,000 kilowatts	0.37	0.04	0.16	0.21	0.78	17.7
3,000 kilowatts	0.33	0.04	0.15	0.17	0.69	17.4
4,000 kilowatts	0.40	0.03	0.14	0.20	0.77	18.8
5,000 kilowatts	0.34	0.03	0.11	0.16	0.64	18.7
7,000 kilowatts	0.36	0.04	0.13	0.20	0.73	17.9
10,000 kilowatts	0.26	0.03	0.09	0.13	0.51	22.6
20,000 kilowatts	0.30	0.03	0.11	0.16	0.60	19.6
50,000 kilowatts	0.23	0.02	0.10	0.11	0.46	20.56

It is to be noted that, even with the largest steam stations, the costs per unit generated are no better than for quite small stations using Diesel engines, and this in face of the improved load factor. This is a most important point, and shows that small Diesel stations can profitably supply current at prices hitherto thought to be obtainable only in densely populated centers having large power stations.

In all cases the figures which have been given are operating costs and do not include anything for interest on capital or depreciation. It is hardly possible to give a definite statement showing the cost of constructing and equipping power houses of different types, as there are so many variable factors. However, the author's experience of a considerable number of estimates indicates that up to a capacity of, say, 1000 kilowatts there is generally little difference between the gross capital expenditure required, whether steam, gas, or Diesel engines be adopted.

Having now dealt with what may be termed the commercial aspect, it may be well to consider briefly the constructional features desirable in engines for dynamo driving. In the first place the dynamo should be coupled direct to the engine shafts, and not be driven by belts or ropes, as the upkeep cost of these is considerable; also, with belt or rope

drive, the space occupied is considerable. Direct coupling of dynamos means that slow-speed engines are to be avoided; otherwise the cost of the dynamos is very high. For speeds which are not slow, engines of the multi-crank type become desirable; otherwise serious vibration is likely to be caused. For the same reason it is important that the distance between the center lines of the cylinders of an engine be reduced as much as possible. If far apart, as, for instance, in the case of a cross-compound steam engine with dynamo between, then each cylinder or line of parts will produce its own vibrating effects on the foundation without being materially influenced or counteracted by the other.

For multi-crank engines with cylinders close together the vertical construction is much more suitable than the horizontal, and gives much better accessibility. Also any unbalanced inertia forces do not tend to slide the engine about, but merely increase or decrease the pressure on the foundations.

The vertical design is also better from the point of view of piston wear. Multi-crank engines are also advantageous as regards speed regularity during each revolution, which is a point of importance when driving alternators in parallel. When high-speed engines are adopted, the multi-crank vertical type becomes imperative, and experience has shown that forced lubrication to all bearings is very much better than any other system of lubrication. Also, with high speeds the crank chamber should be completely inclosed; otherwise a lot of lubricating oil is thrown about. This complete inclosing, combined with forced lubrication, is, in the author's opinion, an absolute essential for high-speed engines, whether steam, gas or oil.

With the first few oil engines to which forced lubrication was applied a portion of the lubricating oil got drawn up into the cylinders. Detailed improvements in construction have, however, completely overcome this, and now the oil consumption is quite as low with the forced lubrication as with the ordinary systems. For moderate speeds of revolution, ring lubricated main bearings are thoroughly satisfactory combined with centrifugal lubrication to crank pins. With such an arrangement less complete inclosing meets all requirements of cleanliness.

The heat efficiency of the Diesel engine, though far from perfect, is still much better than any other heat engine, as is readily seen from the fuel consumption, which is 0.44 pound of fuel oil per brake horsepower per hour. The fuel consumption is also low at partial loads; being 0.45 pound at three-quarters load, 0.47 pound at half load and 0.62 pound at quarter load.

These are not "records" but everyday figures, and for engines of moderate size. With larger engines the fuel consumption is rather lower, but increase of size does not give anything like the improvement in fuel consumption that occurs with steam engines.

Owing to the high economy at light loads it is often found distinctly advantageous to run a Diesel engine in preference to using a storage battery.

The oil generally used is residual petroleum; that is, the residuum left from petroleum after the lighter oils have been distilled off. The increased demand for gasolene will certainly tend to increase the further supply of residuum, while the opening up of new oilwells in various parts of the world is steadily increasing the oil supply.

The fuel oil used can be almost any of the fuel oils which are used for boiler firing, and a wide variety of oils can be used with no alteration of the engine, this being probably explained by the fact that an atomizer which will sufficiently atomize a thick viscous oil can easily atomize the thinner oils. The use of oil fuel carries with it obvious advantages in the way of ease of handling and of cleanliness.

The question may naturally be asked whether Diesel engines are suitable for long periods of continuous running. In reply to this the following instance may be quoted:

At the Birkdale Electricity Works a Mirrlees-Diesel was installed a little over four years ago. The station engineer recently made a report which showed that the engine had, on the average, worked 23¾ hours out of every 24 hours throughout the four years, or an average stoppage of about 1¼ hours each Sunday.

CORRESPONDENCE

Trouble from Long Exhaust Pipes

In reply to H. H. Delbert's letter in the issue of August 22, asking why a long exhaust pipe prevented a 3-horsepower engine from running, I would say that the cause was back pressure directly due to the use of such a length of pipe. The velocity at which the gases start out of the cylinder at the instant the exhaust valve opens is very high; the gases should therefore be allowed to escape as freely as possible in order that equalization of pressure may be practically established by the time the outer dead center is reached.

The use of an extremely long exhaust pipe might readily prevent this condition from being realized. Before the exhaust gases can be discharged into the atmosphere they must set in motion the entire column of air in the exhaust pipe. The heat of the gases also causes the air in the exhaust pipe, nearest the engine, to expand very quickly, while the air at the far end of the pipe would be still cold, thus increasing the back pressure that the engine would have to overcome.

From the foregoing, it is evident that in the case of a small engine the back pressure might prevent the engine from running.

DONALD RENSHAW.

New Orleans, La.

[Mr. Renshaw's argument is sound except as to the alleged increase in back pressure due to the heating of the air in the exhaust pipe. The specific heat of air is very nearly equal to that of exhaust gases. Consequently, the loss of heat by the exhaust gases would cause them to shrink about as much as it caused the air to expand, and the back pressure would not be increased seriously, if at all. It might possibly be decreased by reason of the fact that the quantity of air is much greater than that of gases, and the transfer of any quantity of heat to the air might cause more shrinkage in the gases than expansion of the air.—EDITOR.]

I have had difficulty in operating an engine with a long exhaust pipe, somewhat like the trouble described by Mr. Delbert. My engine is a little one, governed on the hit-and-miss principle and provided with an automatic inlet valve and an arrangement whereby the governor holds the exhaust valve open when an explosion is to be missed; this prevents the suction of the piston from pulling the automatic inlet valve open.

The exhaust pipe is 25 feet long and I found that when the governor came into action the intake valve would be sucked off its seat just as though the exhaust valve were closed. When I disconnected the exhaust pipe, the engine worked all right, so I came to conclusion that the inertia of the exhaust gases in the long pipe was the cause. I put a suction valve in the exhaust pipe, right at the engine, with a spring weaker than the spring of the intake valve of the engine, and after this change the engine ran without any trouble. Whenever the governor came into action, the valve on the exhaust pipe opened, proving that my view of the difficulty was correct. The suction valve also lifted slightly from its seat at every exhaust of the engine, showing that the column of exhaust gases in the long pipe had considerable inertia.

CHARLES A. STREET.

St. Louis, Mo.

Energy from Niagara falls, including operation on both sides of the river, is being used at the rate of 126,000 horsepower for electrochemical purposes, 56,200 horsepower for railway service, 36,400 horsepower for lighting and 54,540 horsepower for industrial services, the total being 273,140 horsepower. This is about 5 per cent. of the power available.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Keep the Heater Clean

It is surprising how much dirt a good heater will separate from the water in a day's run. For economic reasons a heater should be kept clean.

I have an open heater and every morning after starting up I open the blowoff valve, and allow the city water to enter from the top and mix with the exhaust steam, thus thoroughly heating the water and flushing the heater. Then for fear there might be some dirt left at the bottom of the heater I open the city pressure valve on the suction side of the pump, thus forcing the water through the pump into the bottom of the heater; by so doing I have a clean heater for the day.

A closed heater can be treated in a like manner. With a clean heater the soda solution will act on the remaining scales, while before it was simply a hand-to-hand fight between the mud and the compound.

Some time ago I was working in an office building where it was the rule to run boilers six weeks before washing out. When looking in the boilers for the first time I was amazed to see how fairly clean they were, which I later attributed to the fact that the returns from the exhaust were used and the same water was used over and over.

JOHN WALLIN.

Chicago, Ill.

Engine Room Log Book

I have seven large Corliss engines located in different parts of the mill, and have had considerable trouble because the engineers neglected to report difficulties and stops they have had on the night turn. In several cases, knocks that occurred the last of the week have developed into serious trouble when starting Monday morning, with the consequent shutdowns of the different departments, whereas if I had been notified in time the engine could have had a thorough overhauling on Saturday and Saturday night. To overcome this difficulty I installed a log book in each engine room.

It consists of a 9x12-inch Standard diary, with a page for each day. In this book, both day and night engineers enter all happenings during their turn, even the most trivial items. I also have them make a note in this book whenever repairs take place, when new brasses are put on the crosshead or crank pin or when the main bearings are babbitted. In fact, it is a reference book of that engine room.

When I make my daily rounds each morning I always look at this book as it keeps me better posted than I would be otherwise. The engineers also take a great deal of pride in this book, and by putting down the daily happenings and not trusting to memory they can tell exactly how long a part has worn, and what service it has given.

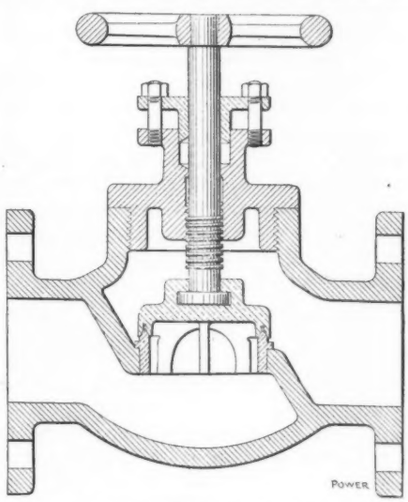
Since starting this book I have noticed that we have had fewer stoppages than heretofore, as my attention is called to defects and they are fixed up at the end of the week.

A. RAUCH.

Swissvale, Penn.

Improved Stop Valve*

Almost every valve used in pipe connection in an engine room leaks more or less. I have had troubles with valves in



IMPROVED STOP VALVE

boiler rooms which I found were caused by faulty construction of the valve and not poor management on the part of the engineer.

In the ordinary stop valves I have used the bearing surface between the valve and its seat is one conical surface and if the valve wears irregularly or a bit of dirt gets in the bearing surface, the valve will soon begin to leak.

To remedy this defect I designed the valve shown in the accompanying illustration, which is a sectional view.

The valve disk is made with an annular inverted V-shaped groove which fits a corresponding elevated surface on the valve seat.

This construction gives the valve disk and seat two bearing surfaces, so there is little chance for steam leakage. If the valve leaks at the inner surface, the steam expands in the cavity of the groove and forms a water packing, and thus prevents further leakage.

The distance of the center of the groove from the center of the valve differs slightly from that of the center of the valve seat's head. When the valve disk is pressed against the seat on the outer edge it springs in to some extent and gives a uniform pressure on the valve seat, thus keeping the valve nonleakable.

YAEKICHI SEKIGUCHI.

Tokio, Japan.

*In the September 12 issue this letter was published, minus the illustration.

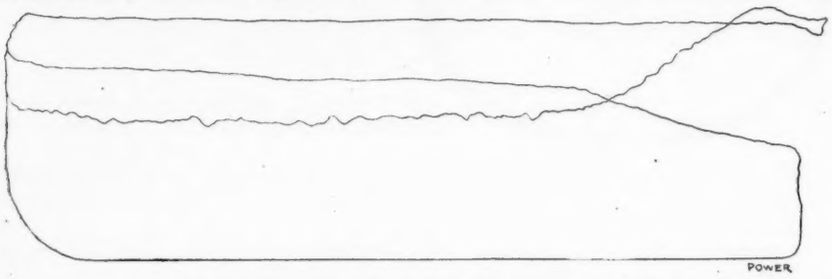
Running Corliss Engine with One Steam Valve

Some time ago I had a discussion with a number of engineers and later with the senior engineering students at the Worcester Polytechnic Institute as to what would happen if the connections to one of the steam valves of a simple Corliss engine should break and leave the valve open and, if the engine ran at all under these circumstances, what kind of indicator diagrams it would give.

There was so much difference of opinion that the experiment was tried on the 10x30-inch Corliss engine, running at 84 revolutions per minute, the test taking place in the power laboratory of the Worcester Polytechnic Institute. Diagrams with an 80 spring were taken while running under normal conditions; the engine was then shut down, and after the head-end steam valve had been removed, very much to the surprise of some, the engine was started again. The engine could not be started by admitting steam to the crank end, but started easily from the usual head-end starting position. The illustration shows the diagram taken with the valve out. With but one steam valve the engine would not carry as much load as before, but the total load had to be kept above that shown by the head-end diagram to prevent the engine from

running away. There was a large drop of pressure between the boilers and engine and in a few minutes the boiler pressure commenced to drop.

The automatic feed-water indicator and recorder had been showing a water rate of about 8000 pounds of feed water per hour, but after running some 30 minutes without the valve the pen was off the chart at 17,000 pounds per hour and the fireman was complaining that he could not keep the water level. All of the change in water consumption was due to taking the valve from this engine as there



DIAGRAMS OBTAINED WITH ONE STEAM VALVE REMOVED

had been no change of load on the other engine that was running at the time. The pressure in the exhaust pipe fluctuated rapidly between 10 and 25 pounds.

Members of the mechanical department, attracted to the boiler room by the evident attempt to use the exhaust head for a steam whistle, seemed to think that it was rather a fool trick to play on an engine. I would fully agree with them if it were not that its very foolishness served to arouse the interest and enthusiasm of a large number of men, and in the discussions, before and after the experiment, many of them got a much better idea of the action of the valve gear of the engine.

In the experiment the only change made was that of removing the steam valve. What effect would it have on the engine if, in addition to the above change, the head-end exhaust valve were disconnected and fastened shut? What kind of diagrams would you get from the engine under these conditions?

C. A. READ.

Worcester, Mass.

Engine Knocks

As I cannot locate a knock in a tandem-compound engine, I would know what some of the more experienced engineers of POWER have to say regarding the trouble.

The knock seems to be in the low-pressure cylinder, and when the load is light, as it is when first starting up, it does not sound very plainly, but as the load picks up there is a very annoying rap in the cylinder as it completes each outward stroke.

W. A. MILLS.

Kingwood, W. Va.

Corrosion of Hot Water Heater

I would like to ask POWER readers what is their opinion of a trouble I am having. I believe the matter deserves careful analysis as it may mean a good deal to any plant; in fact, to any and all hot-water heating service.

Some two years ago I had to replace the hot-water heater, which is a tank 36 inches in diameter and 96 inches long, made with a $\frac{5}{16}$-inch shell and two $\frac{3}{8}$-inch convex heads, carrying a house pressure of 90 pounds at a temperature of 160 or 170 degrees. This water is taken from the city water supply and is heated during the winter by vacuum returns, being passed through 36 feet of 4-inch brass coil in one end, the heater lying horizontal and suspended overhead in the boiler room. If the vacuum returns do not heat sufficiently there is 36 feet of 3-inch either exhaust or high-pressure steam coil in the opposite end controlled by a thermostatic valve.

This tank shell, heads and iron fittings went to pieces, all being eaten entirely through; the edges of the plates at the seams were all gone, the rivet heads in places nearly gone and the shell covered with big red rust blotches, which if cleaned off reached well into the shell, many times nearly through. Cast iron could be cut with a knife as easily as carbon, and in appearance looked very much like it. The tank was replaced by a $\frac{7}{16}$-inch shell with $\frac{1}{2}$-inch heads of the same pattern now in service. I am troubled at times by a red, rusty water which is hard to clear up.

Plumbers are having a good deal of trouble with water fronts and range boilers, and I see no reason why it should not affect all hot-water service.

I have had trouble with my 2-inch hot-water meter. The iron parts went in exactly the same way as the water heater, and the iron inner parts are covered with a growth similar to moss or little needles standing out all over it. By some it is pronounced electrolysis, which I believe is wrong. Others think it is due to boiler compound; this I also think is wrong as I have used this compound for years and I know it has had no injurious effect. Further, the compound does not reach the meter in any way as it passes to the feed line after the water has passed the meter. The compound could in no possible way touch the house hot-water apparatus. What is the cause of my trouble and how can it be prevented?

ASA P. HYDE.

Binghamton, N. Y.

Bushed the Cylinder

In anticipation of rapid growth in business, the new owners of an old shop installed a first-class 250-kilowatt automatic engine and generator. Some years later, the expected increase of business not having arrived, the generator was only delivering 30 to 40 kilowatts most of the time and never more than 50. With such light loads the governor had a bad knock and the economy of the engine was poor.

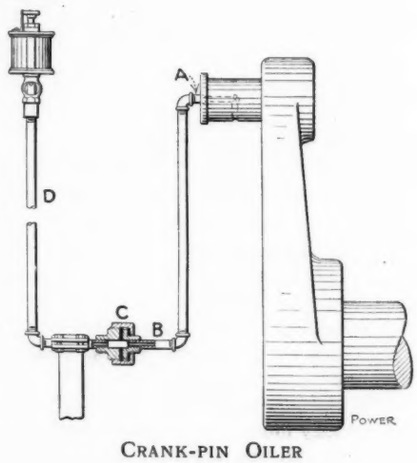
A bushing which reduced the diameter of the cylinder 3 inches and made it more in proportion to the power required, did away with the knock in the governor and improved the economy of the engine very greatly. Of course, a new piston had to be put in also.

F. D. BUFFUM.

Scottdale, Penn.

Crank Pin Oiler

The accompanying illustration shows a simple oiling device. A small hole is shown drilled longitudinally in the end, and another in the side of the crank pin; the holes meet. Into the longitudinal hole a small pipe is screwed which is made of such length that a pipe *B* would be in line with the center of the crank shaft.



CRANK-PIN OILER

A pipe union *C* is fitted with a leather gasket so that the pipe *B* can revolve around in the main part of the union. The pipe *D* and short pipe connecting the two are stationary and supported.

An oil cup with a needle valve regulates the number of drops in a given time. Oil flows down the vertical pipe through the union *C* into the crank pin.

When the crank is down the oil will flow to the crank pin, and at all times the flow is assisted by centrifugal force.

DANIEL ASHWORTH.

Wappingers Falls, N. Y.

Homemade Feed Water Heater

The accompanying illustrations show an open-heater arrangement which I have built and which I have been using over a year. As I was not able to get suitable sheet iron with which to make a heater, I adopted the scheme of heating the cold water by using four oil barrels after first burning out all of the old oil.

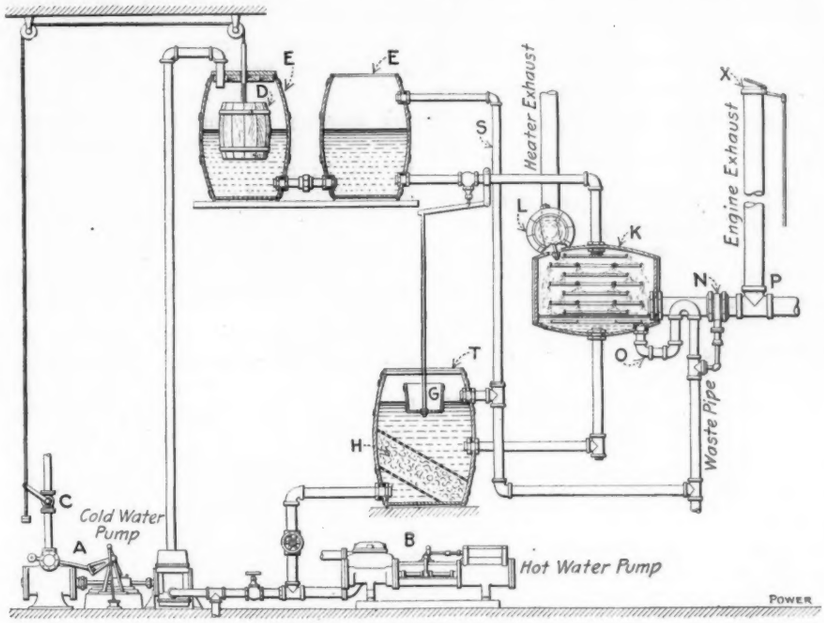


FIG. 1. ARRANGEMENT OF PUMPS AND HEATERS

The cold-water pump *A*, Fig. 1, is used to fill the tank barrels *E E*. By the use of a beer barrel *D*, partly filled with water, which acts as a float and actuates the lever on the valve *C*, the water level in *E E* is thus kept constant. The barrel heater *K* contains sheet-iron pans and wooden strips, about 1¼ inches thick, which are placed between each pan, and holds them firmly in the barrel. The top and bottom pans are made long enough to touch the sides of the barrel, thus wedging the pans together. The barrel *T* contains the hot-water supply and after passing through the packing of excelsior shavings or hay at *H*, it flows to the feed-water pump *B*. The engine exhaust is shown at *P*.

During light-load periods the cap *X* can be lowered, thus allowing more steam to pass through the heater and out through the exhaust *L*. *N* is an oil separator made from the body of a 7-inch gate valve. *O* and *S* are overflows connected to the waste pipe. The water level in *O* should be higher than shown in the sketch. *G* is a small wooden bucket used for a float. *L* is an exhaust head to keep the water from being forced out of the exhaust pipe. With this arrangement I was able to get an average temperature of 190 degrees and when the engine ran lightly the temperature would rise as high as 204 degrees Fahrenheit.

This heating arrangement supplies hot water for two 80-horsepower boilers and there has not been any sign of oil being carried in with the feed water. The water is regulated by an ordinary globe valve which has had the threads on the stem removed.

In Fig. 2 is shown a scheme by means of which the steam end of an engine may be converted into a pump. I had no means of raising the cold-water supply for my heating arrangement, but I had a four-hand, double-acting force pump and an old 5x9-inch engine which I put together without the use of an auxiliary steam valve, common to all single-cylinder pumps. I removed the lap of the valve *A* as shown. The arm *B* was attached to the valve rod. The weight *W* was used as a balancing weight. *D* and *C* are catch rods which actuate the arm *B*. The crosshead blocks *F* and *G* engage with the lug *E* which pulls the crank arm *R* from one side to the other of the rocker shaft, the vacuum cup pulling down on the arm *H*, thus operating the valve. By means of a swivel connection to the dashpot plunger the rod *H* can be shortened or lengthened by screwing it in or out of the head.

The vacuum cup may be improved by using an air-cushion plunger, as on Corliss engines. It was necessary to have springs placed on all the valves in the water end. Although this arrangement may not be of the best design, it shows its feasibility when using a vacuum cup.

C. W. ALLCOM.

Bellaire, O.

Scrub Engineers

When is a man an engineer?

I know of two steam plants which have recently been erected and equipped with the best machinery on the market. One of them is valued at $300,000, and after it was put in operation a carpenter who had been working on the job was given complete control of this plant. There are 30 steam traps, and 10 of them are out of working order; a ½-inch bypass is used to drain the systems. The valves in the bypass pipes are kept wide open.

The traps have been operating a scant three months. The engineer did not have the slightest idea as to how much steam passed through the traps in a day's run.

The other plant has a 150- and a 300-horsepower engine, and a $1.50 night watchman was given entire control over the engine and boiler room as soon as they were put in operation. The engines have never been indicated, and were installed by the laborers about the mill. I have been in the plant on several occasions, and invariably find one of the three engines out of commission. The managers of these two plants seem to be perfectly satisfied with the ability of their engineers.

It is steam plants operated by such men which fall an easy prey to the central station.

J. W. DICKSON.

Memphis, Tenn.

Hot Bearings

I have had success on most all occasions by using cylinder oil and water on hot bearings. I arrange where possible to feed the cylinder oil to the bearing in a small stream and feed the water in the same way and at the same time. This treatment will bring a bearing down to a running temperature in a few hours.

Water should not be applied to hot

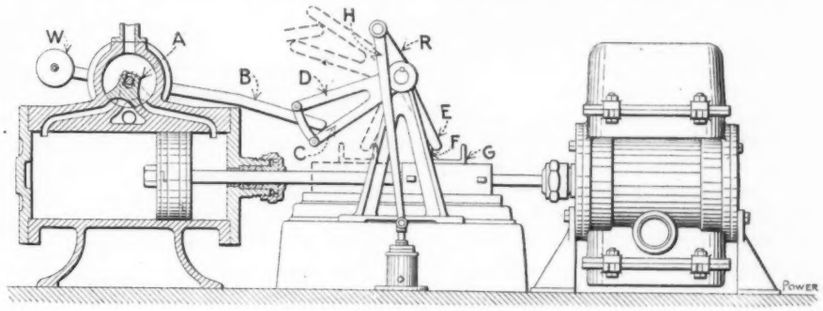


FIG. 2. COMBINED PUMP CYLINDERS

crank pins or main bearings in large quantities as it may cause the cranks or crank pins to become loose. If the heat has had time to travel out into the crank disk from the shaft so that it becomes quite warm and water is applied to the bearing in large quantities, the shaft will contract more rapidly than the disk, and as the engine is operating under load, it has a tendency to loosen the disk on the shaft. Owing to the large body of metal in a crank disk, heat does not radiate rapidly and they will carry heat for several hours after once becoming hot.

Graphite, sulphur and white lead can be used to good advantage in cooling a hot bearing, but they should be used in small quantities and mixed with a liberal amount of oil; otherwise the oil grooves in the bearings are liable to fill up. Where the construction of bearing caps will permit, it is a good plan to put a quantity of raw beef, suet or tallow on top of the shaft. On a rise of temperature of the shaft it will be protected by the grease.

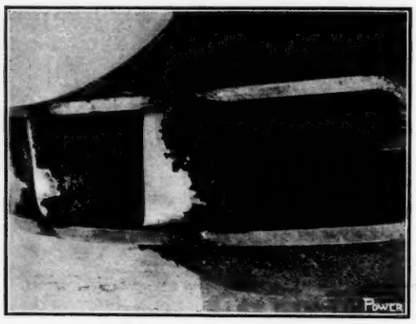
E. P. BAUM.

Pittsburg, Penn.

Erosion of Pump Runner

The accompanying figure shows part of the runner which was recently taken out of one of the circulating-water pumps in the plant in which I am employed. The outer end of all of the vanes in the runner were badly eroded. When I took the photograph herewith reproduced I placed sheets of white paper behind the vanes so as to bring out the nature of the erosion as clearly as possible.

The pump is 16 inches in size and of the double-suction, vertical-shaft submerged type, the runner and casing being completely under water all of the time. The pump is driven by an alternating-current motor. The suction pit in which the pump is placed communicates directly with the Willamette river, water from which is used for circulating in the condensers.



ERODED PUMP RUNNER

I do not think that the erosion is due to mechanical conditions or to oxidation or other chemical reaction between the elements in the water and the iron because the trouble is confined to the ends of the vanes. This fact leads me to think that the erosion is the result of electrolytic action by stray currents or something of that sort.

But as it is claimed that alternating current does not produce electrolysis, my theory does not seem to hold because no continuous current is used anywhere in the vicinity of the pump.

I would be glad to hear from those who have had similar experiences as to what their explanation is and how they overcame the trouble.

JOHN JAMES.

Portland, Ore.

Adjusting the Mercury Columns

One peculiar thing concerning a mercury column not usually noticed is that the surface of the mercury in the pot at the lower end of the glass tube varies in hight; that is, the heavier the atmosphere the higher the mercury rises in the column, hence the quantity of mercury in the pot is reduced.

The scale is fixed securely to the frame, and does not move. Therefore, the surface of the mercury should just touch the lower end of the scale, when the tube is filled, say, with a 28-inch vacuum. Then the reading would be correct. Thus, when the vacuum is destroyed the mercury in the column lowers and the hight of mercury in the pot rises and conceals a portion of the scale at its lower end.

This variance in hight of the mercury escaped my notice until recently. The level in the pot was fully an inch below the lower end of the scale, and when the column registered 27 inches, in reality a 28-inch vacuum existed. I was constantly being deceived by this defect until suitable adjustments were made and correct readings were obtained.

Soon after this the boss, after looking at the column and noting the hight of the mercury, said, "Good for you!" He knew what economy an additional inch of vacuum meant, particularly those "precious" final inches. In reality, the error in the column was corrected and not the vacuum.

In Fig. 1 is shown the condition of the mercury column before adjusting the screw at the lower end, shown at *A* in Fig. 2; *B*, Fig. 2, is the glass tube and *C* the pot of mercury.

LUKE J. B. MARIER.

Fall River, Mass.

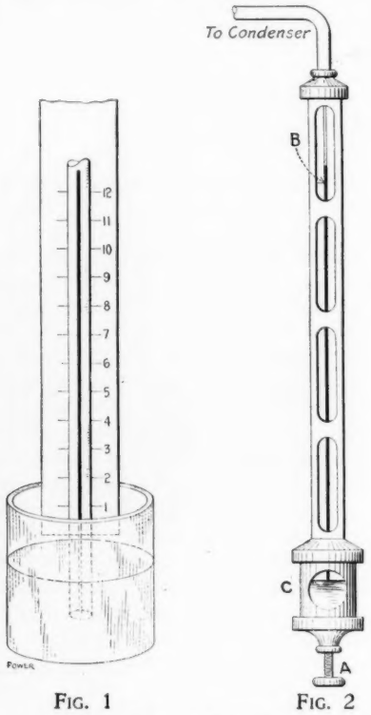


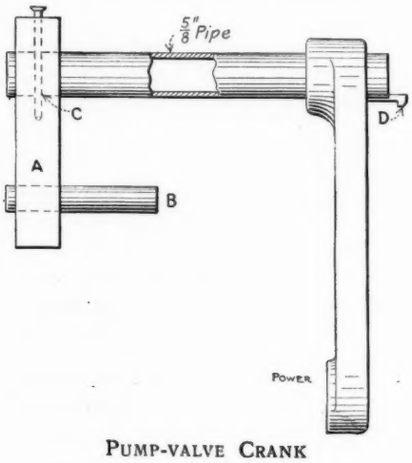
FIG. 1 FIG. 2

MERCURY IN COLUMNS

Makeshift Pump Valve Crank

Recently my feed pump broke down at a time when something had to be done in a hurry to keep the plant running, as it was the only source of feed-water supply.

On entering the pump room I saw one of the valve levers *A* on the floor, the shaft having broken off just where it enters the standard. I drove the key and broken piece from the lever and cut a piece of ⅝-inch pipe, which was of the same diameter as the shaft, but 1½ inches longer. I then got a piece of maple wood and bored it to fit the pipe to serve as the crank *A*. For the pin *B* I bored a ½-inch hole and drove in a hardwood doweling 3 inches long through it. I next filed a flat place on the end of the pipe to act as a keyway and at the other end I drilled a ⅛-inch hole through the pipe. I put on the wooden crank, drove a 10-penny nail through the end of the wood and the hole in the pipe at *C*, to prevent the crank from turning. Then I put the pipe through the standard, put the lever on the end and drove home the key *D*. The pump ran for three weeks, until a new shaft had been made.



PUMP-VALVE CRANK

FRED WAGNER.

Chicago, Ill.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Leaky Boiler Tubes

Some engineers seem to have trouble with leakage at the boiler-tube ends. Leaky tubes always indicate to my mind improper care, especially with horizontal tubular boilers. I have charge of boilers of this type that have run for years without signs of tube leakage and they are worked up to their rated capacity.

Probably the greatest cause of tube leakage is badly scaled tube sheets; another is pumping in cold water; especially when the fire is low, one must always have a brisk fire when pumping up; otherwise the water will not have the same temperature in all parts of the boiler and will cause severe stresses in the shell and tubes, with leakage at the seams and tube ends and possibly cracks. Keep the damper closed; cold air drawn through the furnace is harmful when the fire is low or banked.

If possible, always fill the boiler with water at a temperature of 140 degrees or more. It is not of much use to advise an engineer to keep his boilers free of scale if his employers do not furnish him the proper facilities, but cleanliness is the main requisite in doing away with boiler troubles.

J. O. Benefiel.

Anderson, Ind.

Central versus Isolated Plant

In all of the recent discussions on the above subject, one point seems to be conspicuous by its absence. In many plants great wastes occur which might be stopped at little cost, but the central-station solicitor, knowing his business, fails to point them out.

This was forcibly brought to my attention some time ago, when I was called into a plant which could not carry its load, and at times would have to shut down for several minutes until steam could be raised to running pressure. The owner said that he had almost decided to let the central station in, as they would guarantee to give him his power for less than half his present cost, and he figured he could furnish his own heat and be money ahead.

A short inspection revealed amazing conditions. The feed-water heater, of the closed type, had been cut out of service three years before because of leaks and had never been repaired. It was also almost completely filled with scale. The heating pipes refused to warm up sufficiently with exhaust steam and live steam was used to help out. A foundry blower, running at 128 revolutions per minute with the relief valve blowing constantly, was driven through four belts and a pair of cast gears. The master mechanic (?) explained that by first speeding up and then down he was saving power. When asked why he did not add a few more belts to the line and run without power he was insulted.

Steam was used for heating the water tanks and for other industrial purposes but only one steam trap, and that not working, was found about the plant. Almost all the steam lines were uncovered. There were a lot of other equally evident causes for loss which any self-respecting engineer should have noticed.

The heater was cleaned, repaired and again put in use; the heating system was overhauled, numerous so called vapor pipes were plugged up, and one back-pressure valve installed. The shops were then heated better than before, and with exhaust steam only. The speed of the foundry blower was cut from 128 to 65 revolutions per minute and the pressure remained as before, the relief valve working only when some of the furnaces were shut down; the belting was changed so that one belt took the place of four and a pair of gears; traps were installed, the steam lines were covered, and other glaring faults were remedied.

The coal consumption was so much reduced that the owner was induced to install new boilers and furnaces which would burn a cheaper grade of fuel and do it without smoke. This was absolutely necessary as the boilers were over 20 years old—how much more nobody seemed to know—and were of the lap-seam species. The boiler inspector had already cut them down to 75 pounds.

After this installation the cost had fallen to practically the same amount as the central-station estimate, and this included the heating. While the electric drive was considered, the expected saving would not warrant the investment required for motors and an electric generator.

The central-station solicitor, when shown the results after a six months' run, did not bother the management further. Had the central-station service won out, the above wastes would have been cut out and they would have made good, but certainly they would not have told anybody just where the saving was made.

It seems to the writer that in many cases where the central station has won out, they have done so not by furnishing power cheaper per kilowatt-hour, but by cutting out these inexcusable wastes and then furnishing less power than was formerly required at a lower total cost.

John Bailey.

Milwaukee, Wis.

Prevention of Wet Steam

After reading Mr. Gilbert's article concerning the trouble he is having with priming boilers, I would like to offer a few suggestions which may prove of assistance in overcoming the difficulty.

First, I note that the feed water is bad, and that different treatments have been tried. There are lots of compounds that will cause priming if used to excess. I find that soda ash when used alone or, in fact, any boiler compound containing soda ash or caustic soda—and a great majority of them do contain it—will cause violent priming and foaming. The safe remedy is to use a little less compound and give the boiler washer more time when the boiler is off, and see that he gets the dirt out. There is nothing like "human" compound when getting the dirt out of a boiler.

Second, the location of the feed-pipe nozzles on the inside of Mr. Gilbert's boilers may be too close to the steam nozzles or outlets. This arrangement will cause priming or the pulling over of water in case of a sudden increase of load or the sudden starting of an engine.

Third, the construction of the dry pipes may be at fault. They should be of sufficient size and length and the perforations should all be on the top half of the pipes and of sufficient number to be equivalent in area to the area of the steam outlet.

Fourth, a surface blowoff might be installed advantageously.

Fifth, the question of installing steam drums according to Mr. Gilbert's idea raised by the insurance and inspection companies should be looked into. There are certainly some commendable features about the idea.

Sixth, some of the trouble may possibly be due to pockets in the steam

header. The proper drainage of the header by installing traps and separators may go a great way toward eliminating the much dreaded shutdowns. In purchasing traps, look closely to the construction and be sure that all valves in connection with the trap have the same area of opening as the pipes used in connection with them.

Seventh, I would suggest that even though it is possible to carry the load on two boilers, three boilers be used. This will eliminate the possible necessity of crowding the fires and will increase the steam-making capacity with less violent circulation.

THOMAS M. STERLING.

Middlebranch, O.

Lifting Water in Boilers

In the September 12 issue, F. J. McMahon takes exception to statements in a recent letter of mine. He brings out some theories on boiler operation that are new to me. For instance, he states that "it is the generally accepted theory among engineers that practically all the water in a boiler is at the temperature corresponding to the pressure of the steam."

If that is the case I cannot account for the circulation in a boiler, for if there is no difference in temperature there will be no circulation.

I have heard that theory advanced to explain the absence of locomotives that have been left standing for some time with a hot fire, and suddenly started.

Personally, I should not care to have charge of a boiler with all the water at or very near the flashing temperature.

As for the water in a boiler condensing the steam, it may to a small extent. But the amount of heat which can be transmitted downward is very small in any case and where the temperature difference is only a few degrees it can be neglected.

Again, he says, "the amount of feed is so small that it has practically no effect on the temperature of the water in the boiler."

When the fires are in bad shape, or at clean-out time, many engineers shut off the feed as long as they can and imagine that it makes quite a difference with the steaming of the boilers; in most of the plants the feed water goes into the boiler at a temperature of 210 degrees Fahrenheit.

In several types of water-tube boilers the continuity of the feed is very important; the feed is started when the engine is and is kept on as long as the engine runs.

Exception was also taken to my statement that the pressure rises under the conditions of a bursted steam pipe or opening to a lower pressure.

What bursts the boiler if the pressure does not rise; it cannot be the lower pressure?

Large steam pipes have burst and boilers have been cut in at almost any pressure over the line pressure with no damage to the boilers. In other plants under practically the same conditions, bad explosions have resulted.

It is my opinion that the amount of water in the boiler near the flashing point determines if the boiler will explode when the pressure is reduced suddenly.

In my first letter what I wanted to know concerned the water-hammer theory which we have heard so much about lately.

A few years ago, when a boiler let go, everyone looked wise and said, "low water," and if the engineer maintained that the boiler had plenty of water in it, he was not believed. Now when a perfectly good boiler lets go, they say water hammer.

Never having had any personal experience with a boiler explosion, but from closely observing those boilers that have come under my charge, in some trying times, I cannot see the water-hammer idea, but am open to conviction.

C. G. HARDEN.

Chicago, Ill.

Locating Keyways in Corliss Valve Stems

In the September 12 issue, L. Johnson gives his method of locating keyways in Corliss valve stems. Some time ago I had a new set of valve stems made to replace the old ones, which were badly worn, and the exhaust valve stems were also bent due to pieces of a broken piston being caught in the ports by the valves.

The valve stems were turned in the machine shop and fitted to the valves which were then put in place in the cylinder; the valve-stem crank was put on and the valve rod screwed in about half way; the wristplate was set central and the steam valves set with ⅛-inch lap and the exhaust valves with $\frac{1}{16}$-inch lap; the valve rods were screwed in about half way to allow for lengthening or shortening, as might be required.

A combination square with center-head attachment was then placed across the end of the stem and crank and a line drawn through the center of the keyway in the crank and the center of the end of the stem. The stem was then taken out and as the key was ½x½ inch in size, a line was drawn on each side of the center line ¼ inch from and parallel to it. A ½-inch hole was drilled at the proper distance for the end of the keyway, which was then cut out in the shaper. After the valves were assembled and the engine started up, several indicator cards were taken at different loads and only a small amount of adjusting was found necessary.

I believe this is a quicker and more accurate method of locating the keyways than that used by Mr. Johnson, especially if the stems are bent.

J. C. HAWKINS.

Hyattsville, Md.

Christie Air Steam Engine

The description of Mr. Christie's engine as published by POWER is worth the attention of engineers because it clearly points out absurd promises of performance and suggests that a loss instead of a gain may result in spite of the complex design and "round-about way of getting at it."

Without delving into the matter minutely, on the surface it appears that no more work will be accomplished per pound of steam than if compression of steam were carried back to initial pressure, in which case the loss due to engine clearance vanishes, as nicely proved in Kent's pocketbook.

A mixture of steam and air may have magic properties heretofore unknown, but all engineers know that about one-fortieth the volume of the medium now used, called steam, consists of air, and trouble enough is had with that 2½ per cent. in getting it out of the condensers. How will this engine operate with a condenser? How can it expand to a pressure below atmospheric economically? Why not compress air with a real air compressor, allow it to mingle with its "critical" percentage of steam at the same pressure and use the mixture in a steam turbine or steam engine on trial? Why build an expensive engine to verify an absurdity?

W. F. SCHAPHORST.

Brooklyn, N. Y.

Mr. Rockwell's Questions

One question in particular in H. R. Rockwell's letter, September 12 issue, attracted my attention because, not very long ago, I had occasion to ask a similar question: "Will turning cold water into a red-hot boiler cause an explosion, and if so, why?"

Two years ago I saw an article in the September, 1909, *Railway and Locomotive Engineering* bearing on the matter of pumping cold water into a red-hot boiler. Boiled down, it said: "Experiments were made in Philadelphia with overheated plates, under the supervision of the Franklin Institute. Several boilers were overheated and cold water was pumped upon the red-hot sheets. The experiments were very conclusive that the whole mass of the boiler, if heated red hot, does not contain heat units enough to raise the water to a dangerous steam-making pressure. All men operating boilers should remember not to let the

water get low. But if by accident it should become low, *hurry to put water inside.*"

I wrote to a boiler company in Philadelphia about the foregoing quotation and asked the opinion of its engineers. This, in part, is what they said in reply:

"We quite agree with you that it is better to smother the fire and let the boiler cool to a certain extent before pumping in cold water. For, even admitting that it might not cause an explosion to pump cold water into an overheated boiler, there are other reasons why this practice should not be countenanced. In other words, our boiler experience has not confirmed the value of the suggested practice."

Again, the *Locomotive* of March, 1893, has this to say: "* * * But we may feel pretty confident that a longitudinal strain of somewhere in the neighborhood of 8000 to 10,000 pounds (referring to a certain case) per square inch may be produced by the feed water striking directly upon the plates; and this, in addition to the normal strain produced by the steam pressure, *is quite enough to tax the girth seams beyond their elastic limit,* if the feed pipe discharges anywhere near them."

CHARLES J. MASON.

Scranton, Penn.

Lubricator Condenser

In the issue of August 15, Mr. Dickson criticizes an article by Mr. Wallace in the July 4 number wherein the latter states his belief that a lubricator condenser should be placed at the top of the standpipe instead of in the usual place at the bottom.

We are all aware that a lubricator works properly with the condenser in its usual position, but, just to take your mind off the current ball scores for a few minutes, is there not a better place for it?

Having held the same view as Mr. Wallace for a long time, I was interested in Mr. Dickson's attempt to prove that there was no advantage in the suggested change. Instead of submitting any proof of his contentions, he simply makes some assertions which evidently we are supposed to believe.

For instance, "The condenser will condense a greater volume of steam in a given time in its present position than it would 2 feet above the lubricator." Why? And, again, "Mr. Wallace leads his readers to believe that this chamber is to condense steam continuously." At least, Mr. Dickson will surely admit there is steam condensed "continuously" somewhere at a rate equal in volume to the oil fed; it certainly is not condensed in the so called condenser.

Also, let us be charitable and believe Mr. Wallace is not the type of engineer (?) to habitually blow out the lubricator at each filling. If Mr. Dickson has ever had the care of several engines in a power plant he will realize that trouble comes in bunches at times, and the filling of a lubricator at the proper time is sometimes neglected; at such oversights it is handy to get the oil feed started again without waiting for the requisite condensation to take place.

Because makers have adhered to the custom of placing the condenser immediately above the lubricator is no reason why there is not a better place for its attachment.

J. A. CARRUTHERS.

Hosmer, B. C.

On Various Subjects

Referring to the issue of August 22, there are several letters on pages 294 and 295 which in my opinion are open to discussion.

I think Mr. McGahey could have saved some time and labor by drilling a

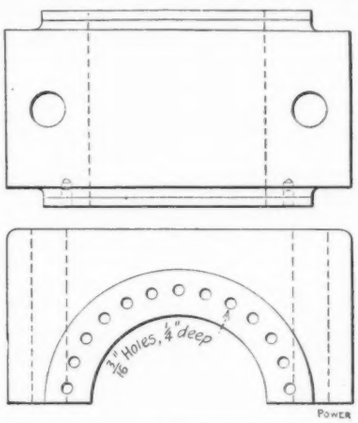


FIG. 1. METHOD OF BUILDING UP CRANK-PIN SHELLS

number of 3/16-inch holes in the sides of the shells, as shown in Fig. 1, herewith, and filling in the required amount of babbitt, to build them up and prevent side play.

While I do not wish to criticize Mr. Hodges' piston-rod drift outfit as it is a good idea, I do wish to point out that

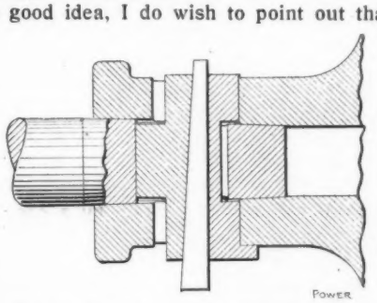


FIG. 2. USUAL DESIGN OF DRIFT-PIN OUTFIT

it cannot always be used conveniently. For instance, on the job he illustrates, without taking out the wristpin, or on a sleeve coupling. Fig. 2, herewith, shows the outfit I use.

The keeper shown in Mr. Handley's letter has been used for years by the Ide Engine Works.

Mr. Beets' rig is much too elaborate. Those shoulder bolts were made in a

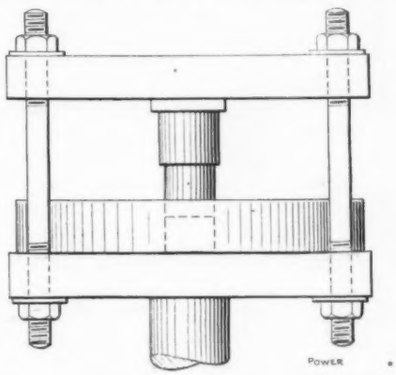


FIG. 3. ARRANGEMENT FOR PRESSING IN CRANK PIN

lathe and the end pieces are forgings. The jack screw is a fifth wheel, so to speak. Fig. 3 shows the rig used by poor people.

CHARLES BENNETT.

Chicago, Ill.

Flywheel Explosion at West Berlin

In the article under the above title in the August 29 issue the statement is made that the inspector, after making an examination of the wreck, "expressed himself as being satisfied that it was not caused by either neglect or carelessness on the part of anyone."

Such a finding could only be correct if the accident had been caused by some flaw in the material of which it was impossible to learn until after the accident had brought it to light. Further in the article the writer states that the probable cause of the trouble was that "the circuit-breaker had been expanded from the heat of the few days past and would not open."

If this were so, it would tend to show that the circuit-breaker was in very poor condition and had not been so well looked after as the engines, whose governors and belts, we are informed, were in perfect condition. The circuit-breaker should have been considered as much a part of the safety apparatus as were the engine governors and kept in such condition that it would not have failed in the manner it did.

The article seems to indicate that there was carelessness either by the man who took charge of the switchboard in not keeping the apparatus in first-class condition if he had the parts with which to do so, or else by someone else "higher up" or in the office in not seeing that those parts which were defective were replaced by good ones before they were too much worn to operate safely.

G. H. MCKELWAY.

Brooklyn, N. Y.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Boiler Room Whitewash

How can a good whitewash for boiler-room walls be made?

C. E. N.

Take ½ bushel of freshly burnt lime, slake it with boiling water and strain the liquid through a fine sieve. Add to it 7 pounds of salt, dissolved in warm water; 3 pounds of ground rice boiled to a thin paste and stirred in boiling hot; ½ pound of powdered Spanish whiting; 1 pound of clean dissolved glue. Add 5 gallons of hot water, stir well and let stand a few days covered from dirt. It must be put on hot.

Working Pressure in Cast Cylinder

What pressure would be allowed in a cast-iron cylinder 36 inches in diameter and ⅞ inch thick?

S. H. P.

The bursting pressure of an ordinary cylinder would be calculated by the formula

$$\text{Bursting pressure} = \frac{\text{tensile strength} \times \text{thickness}}{\text{radius}}$$

Assuming the strength of the iron to be 14,000 pounds per square inch and inserting the numerical values in the equation, it becomes

$$\frac{14{,}000 \times 0.875}{18} = 680 \text{ pounds}$$

The working pressure depends on the factor of safety used. In some cases, such as mangle cylinders, the factor should be high.

Dynamo Voltage

If a dynamo, direct current, is supposed to be run at 110 volts, will it hurt the dynamo if it is run any length of time at 50 volts, or at any low voltage?

J. F. R.

It will not harm a 110-volt direct-current dynamo to run it at a lower voltage, but it would be impracticable with a self-exciting machine, and if the dynamo was separately excited the machine would spark badly at the brushes.

Centrifugal Pump with Closed Discharge

A centrifugal pump has a valve on the end of the discharge pipe. If this valve is closed while the pump is running, will it take more or less power to drive it?

U. W. D.

The power absorbed by a centrifugal pump is that required to take the water which comes in at the center, practically inert, to overcome its inertia and get it into motion at such a velocity that its centrifugal force will overcome the head. When the discharge valve is closed no new water comes in at the center, and it takes comparatively little power to keep the water inclosed within the case revolving after it has been gotten into motion. A trolley car, for instance, would pull much harder if a stream of men were continuously getting in upon one side and getting off upon the other, for every man who got on would pull backward upon the car with a force sufficient to overcome his inertia.

Duplex Pump Cushion

What prevents the pistons of a duplex pump from striking the cylinder heads?

D. P. C.

At each end of the steam cylinder there are two ports, steam and exhaust. As the piston approaches the end of its travel it covers the exhaust port, preventing the escape of steam and forming a cushion in the clearance space which stops the piston. The larger sizes of pumps are equipped with valves by which the amount of compression may be regulated.

Effect of Vacuum on Turbine Efficiency

What increase in efficiency may be expected in turbine operation by a change of vacuum from 22 to 28.5 inches?

W. J. H.

The effect of change of vacuum upon the water rate depends upon the type of turbine employed, the design of the particular turbine with reference to the use of high vacuum, the connection between the turbine and the condenser, the load factor and the point of departure of the change; that is, the effect would be greater, with a turbine adapted to utilize the difference, if the vacuum were changed from 28 to 29 inches than as though it were changed from 10 to 11 inches.

S. L. Naphtaly, in reporting a test of a 10,000-kilowatt Westinghouse double-flow turbine (see *Proceedings*, American Society of Mechanical Engineers, volume 32, page 1251) says, "From this and other tests it was found that 1 inch of vacuum affected the steam consumption 3 per cent. and 6 per cent. at full load and half load respectively."

The General Electric Company's engineers figure a variation of from 1 to 1.2 pounds in the water rate per kilowatt-hour for each inch of vacuum. R. M. Neilson, in "An Investigation as to the Most Economical Vacuum in Electric Power Stations Employing Steam Turbines and Cooling Towers," read before the Institute of Electrical Engineers in 1909, assumes the effect of departure from a 27-inch vacuum as follows:

Vacuum	25	26	27	27.5	28	28.2	28.5
Variation in water rate, per cent.	+7.3	+4.12	—0	—2.42	—5.1	—6.22	—8

Speed of Machinery at Night

Why do engines, waterwheels and other machinery seem to run faster at night than during the day?

L. A. F.

All natural forces act the same at night as during the daylight and produce the same results, and there is no foundation for the statement that machinery seems to run faster at night than in the daytime for it does not.

Gearing for High Rate of Speed

What is the best form of gearing to run at 1800 revolutions per minute transmitting 25 to 30 horsepower without jar or noise?

L. A. M.

It is not possible to make gearing which will run silently or anywhere near it at high rates of speed. Inclosed in oil-tight cases and well lubricated, accurately cut spiral gearing similar to that used in the DeLaval steam turbine will run with less noise than any other.

Foaming Boiler

What makes the water in a boiler foam and go over to the engine in large quantities?

G. K. E.

Foaming in a steam boiler is caused by foul or dirty water. The water should be changed often and kept as clean as possible by blowing both on the surface and at the bottom every day.

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POWER

Efficient Lubrication

While a material reduction in the annual oil bill of a power plant may mean quite a sum in itself, the total oil bill may be so small a part of the operating expense that even a large saving may appear negligible when expressed in percentage of the total cost.

Fuel is the largest single item of expense incurred in the operation of a steam-power plant and a saving of one per cent. in the quantity needed for a given output may, and often does, amount to more than the entire oil bill for the same length of time. In the operation of moving machinery the lubrication has a marked influence on the power required to move it, and, next to the fuel question, that of lubrication is the most important apart from labor.

There are well authenticated instances in the use of oil where changes in the methods of lubrication and in the quality of oil have resulted in the saving of thousands of dollars per year in the cost of operation, while the cost of the oil used was only a few hundred dollars. It was in the boiler furnaces that the saving was made by the substitution of an oil that reduced the friction of the machinery throughout the plant.

Where one part of a machine moves upon another, it is necessary that the moving surfaces be separated by some substance which shall, while preventing the contact of the moving parts, have a movement within itself which allows the molecules to slide, one over or by another, with the least possible resistance. It is a fact too well known to be repeated that any oil is better than no oil, but so long as to many engineers and plant owners oil is oil, and the cheapest is the best because it is cheap, good money which might go to increases in profits and salaries or to the hiring of better men, will be wasted in unnecessarily large coal bills.

Good lubrication is an art which is founded on the science of common things. There is nothing mysterious about it, and it may be mastered in a short time by a little patient, intelligent observation.

If a heavy body is to be moved it is usually put on rollers, and the greater the number of rollers used and the better their condition the more easily the body moves. If the rollers touch each other there is surface friction between them, and the smoother the rollers the less will be this friction. If balls are substituted for rollers the result is the same.

When a shaft has a film of oil between it and the bearing it is as if it were supported by balls which rub against each other as the shaft revolves, and that oil in which the balls move most easily against each other will allow the shaft to move with the least friction.

As a heavy body requires larger and stronger rollers to support it while being moved than a lighter one, so a large shaft carrying a heavy weight requires a more viscous oil, one in which the molecules will not so easily slip from one another and be crushed or forced from between the surfaces.

Viscosity is the quality of stickiness or resistance to internal movement, and in its use for lubrication that oil which offers the least resistance to flow within itself, and which is heavy enough for the work to be done, will be found to be that which will allow the machinery to be run with the lowest coefficient of friction.

Power from the Sun

Direct utilization of the sun's rays for producing power is not new; it has been the subject of more or less experimentation for centuries, but up to the present time it has failed to attain a position of commercial value. It has been in somewhat the same class as the wave motor; both are practical so far as producing power is concerned, but the great drawback in both cases has been the great initial cost and the large amount of space occupied in proportion to the power developed.

The sun-power plant, however, has one advantage over the wave motor. The latter, owing to its nature, must be set up on the coast and is thus forced to compete against coal where the transportation rates are low. The sun-power plant, on the other hand, finds its greatest field for application in tropical regions many hundred miles from the coast and where, owing to the difficulties of transportation, the price of coal is almost prohibitive. In such regions the extra area covered by such a plant is of no importance and if the first cost can be kept within moderate limits there seems to be no reason why a sun-power plant should not be a commercial success, especially for irrigation purposes.

The plant described elsewhere in this issue appears to have been designed with the foregoing points in view; the cost is

not excessive and the whole installation is easily made portable, being so arranged that it may be packed for easy transportation. Moreover, its inventor has made no extravagant claims for the plant, but admits its limitations.

The tests recently conducted at Philadelphia are not conclusive; in fact, they did little more than to demonstrate that the plant would run and to indicate its possibilities under the conditions for which it was designed. Furthermore, certain features of the equipment are more or less crude and it is reasonable to assume that, as the development progresses, refinements will be made tending toward a reduction in cost and greater efficiency.

Calculations based on the experiments thus far made seem to point to the success of the system; but, of course, its commercial value can be proved only by actual service.

The Factor of Safety in Steam Piping

In the following table is shown the thickness of the shell in standard-weight steel pipes and also the pressures at which they will burst. This table embraces sizes of four to twelve inches inclusive:

Size of Pipe, Inches	Thickness of Shell, Inch	Bursting Pressure, Lb. per Sq.In.
4	0.23	5880
5	0.25	5130
6	0.28	4614
7	0.30	4290
8	0.32	4000
9	0.34	3846
10	0.36	3648
12	0.37	3120

On the basis of two hundred pounds static pressure it may be noted that the factor of safety against bursting the pipe is so high that the question of the strength of the pipe in this respect is eliminated. The factor of safety against rupture from longitudinal strains due to the same internal pressure is more than double that for bursting.

This is based on the pipe being full weight and having flanges which will develop the full strength of the pipe.

In steam piping, however, there are other strains than those due to the internal pressure, and unless provision be made to take care of them the factor of safety of the system will be seriously affected. They are those incident to the operation of the plant, and it is not the pipe but the fittings which suffer from them, and unless the layout is properly designed they will far exceed those strains due to static pressure.

Variations in temperature during the operation of the plant produce movements in the piping, and in order to preserve its integrity, the piping between fixed points must bend back and forth. If it does not bend, something will break.

Records have been taken of the movements of certain points on a steam main for a period of one year, and they made a sawtooth line. One of these records showed that the point moved back and forth from five to ten times per minute—the length of travel being approximately one inch. This movement is continuous throughout the life of the plant.

The effect of this upon the fittings is obvious. They must be sufficiently strong to bend the pipe as the main moves back and forth. It is in the fittings therefore that the factor of safety must be most jealously safeguarded. They not only must be of great strength, but the pipe must be as flexible as possible to reduce the strain on the fittings to a minimum.

Extra-heavy pipe will increase these strains on the fittings and thereby defeats the purpose for which it is installed.

From this point of view the factor of safety with full-weight standard pipe is higher than with extra-heavy pipe.

In the design of steam piping for modern power houses it is the usual practice to have all fittings very heavy and strong, and the pipe of full weight standard with either Van Stone or welded-on flanges.

High Vacuums

When steam flows from a region of higher to a region of lower pressure a maximum velocity of flow is reached when the lower absolute pressure becomes about fifty-eight per cent. of the higher. After this it makes no difference how much the delivery pressure is decreased, no more steam will flow per second because the energy due to the next increment of expansion is not sufficient to get up the increase of velocity which would be required to pass the increased volume.

This fact is of prime importance in turbine design, but it is only recently that its bearing upon condenser practice has been noticed. If the engine cylinder be considered the region of higher and the condenser that of lower pressure, and it is recognized that the pressure in the throat of the connecting pipe can never be less than fifty-eight per cent. of that in the cylinder and the velocity of flow only that due to the expansion from the cylinder pressure to fifty-eight per cent. of that pressure, the futility of striving for a high vacuum in the condenser and then connecting it by small and crooked pipes and restricted ports to the cylinder becomes apparent. If the ports and pipes are large, the pressure in the cylinder will run down more swiftly, but it will always be at least 1.7 times the absolute pressure in the condenser so long as the steam is flowing.

The greater vacuum will not pull the steam out of the cylinder any faster, but to utilize it properly ports and pipes must be increased in proportion to the increased volume of the low-pressure vapor. A pound of steam in a twenty-nine-inch vacuum occupies 3.78 times as much volume as in a vacuum of twenty-six inches.

Offhand Verdicts

When an accident occurs in a power plant sometimes the cause is easily determined; sometimes it is never known, and in this case there are always those who, even from afar, can tell offhand just where to place the blame.

When the engineer is dead the blame for an accident is usually placed upon him and the matter is dropped. When he escapes and is in a position to deny charges of neglect or incompetency, the complexion of things is changed and generally the facts of the case are available.

Recently a flywheel accident occurred which, according to one contributor, was caused by the governor belt running off the pulley and the safety device failing to operate. This diagnosis was evidently the result of "absent treatment," because later on the chief engineer, who had not been injured, proved that this deduction was erroneous and that the engines were in proper condition. He found after a very thorough and careful investigation that the accident was due to one of the generators becoming motored, and that the circuit-breaker failed to operate as the latch had expanded from abnormal heat. The facts were no sooner known than the long-distance verdict was rendered that the engineer was responsible for the circuit-breaker sticking and that it was his business to have it in working order. Such a verdict is unreasonable.

This plant was old, the machinery was old and was being taxed beyond its capacity. The company knew all the conditions under which it was being run, and it is not known that they have censured the chief engineer. When they do, it is time for others who are ignorant of the facts to take the stand and give forth their adverse opinion.

In stating the performance of an engine or steam turbine, the figures are usually given in the pounds of steam consumed per kilowatt or horsepower per hour. Now, while the statement may be absolutely correct as to the quantity of steam used and power developed, it does not give exact information unless accompanied by definite information as to the quality of the steam used. This being known, the work done may be readily translated into B.t.u. per unit of power developed, which is the rational basis, and the only one upon which intelligent comparisons of different types of heat engine can be made.

Some astonishing engine speeds were noted in a recent automobile race in England. One engine made 2490 revolutions per minute and 1794 feet per minute piston speed as an average for the race, the maximum speeds being considerably higher.—Ex.

Alcohol has not been a success in Germany as an industrial fuel.

Refrigeration Department

Principles and operation of ice making and refrigerating plant and machinery

Sheffield Farms Companies' New Plant

By Warren O. Rogers

Concentration of power-plant machinery is one of the factors which permit economical operation. In power plants in which the output is electrical energy the generating units and boilers are placed as near together as conditions will permit, and all unnecessary waste from auxiliaries is eliminated as much as possible.

In constructing a combination power and refrigerating plant the concentration of machinery becomes more complicated and of a different nature than in the case of the simple power plant. The matter of auxiliaries exhausting, either to the atmosphere or into a condenser, must be considered, and if a better method can be worked out to eliminate the steam auxiliaries, so much the better. These problems came up in the installation of the new refrigerating and power plant of the Sheffield Farms-Slawson, Decker Companies, which has recently been erected at 170 Manhattan street, New York City. The plant is designed in duplicate and in order to reduce the steam consumption all of the generating and refrigerating machinery is driven from two main steam units.

This power plant is located in the basement of the brick building occupied by these companies. To be in general keeping with the cleanliness demanded by the nature of the work, the engine-room walls are built of stone which are plastered and then painted white, with black block lines at what would be the joint were concrete blocks used. The floor is made of concrete and the foundations of the engines and compressors are lined with glazed brick. The ceiling is painted white and all piping is protected by a suitable covering which is also painted white. The combination gives the engines a neat, clean appearance.

There are two 16 and 30 by 42-inch cross-compound Fishkill Corliss engines which are run condensing and each is belted to a line shaft which runs the width of the engine room at the back. These engines run at a speed of 80 revolutions per minute and each is equipped with a 14-foot flywheel, having a 50-inch face. The piping between the high- and low-pressure cylinders of both engines is so designed that if the load on one engine becomes too heavy, but not enough for both engines to operate at their point of greatest efficiency, the crank on the low-pressure side of one engine can be disconnected and the valve gear unhooked and the high-pressure cylinder on the disconnected unit made to exhaust into the condenser.

In the engine room are also installed two 80-ton double Penney ammonia compressors, each side having a 14x36-inch cylinder. A 14-foot flywheel is fitted to the shaft of each machine, each wheel having a 50-inch face. The machines are belt driven at a speed of 60 revolutions

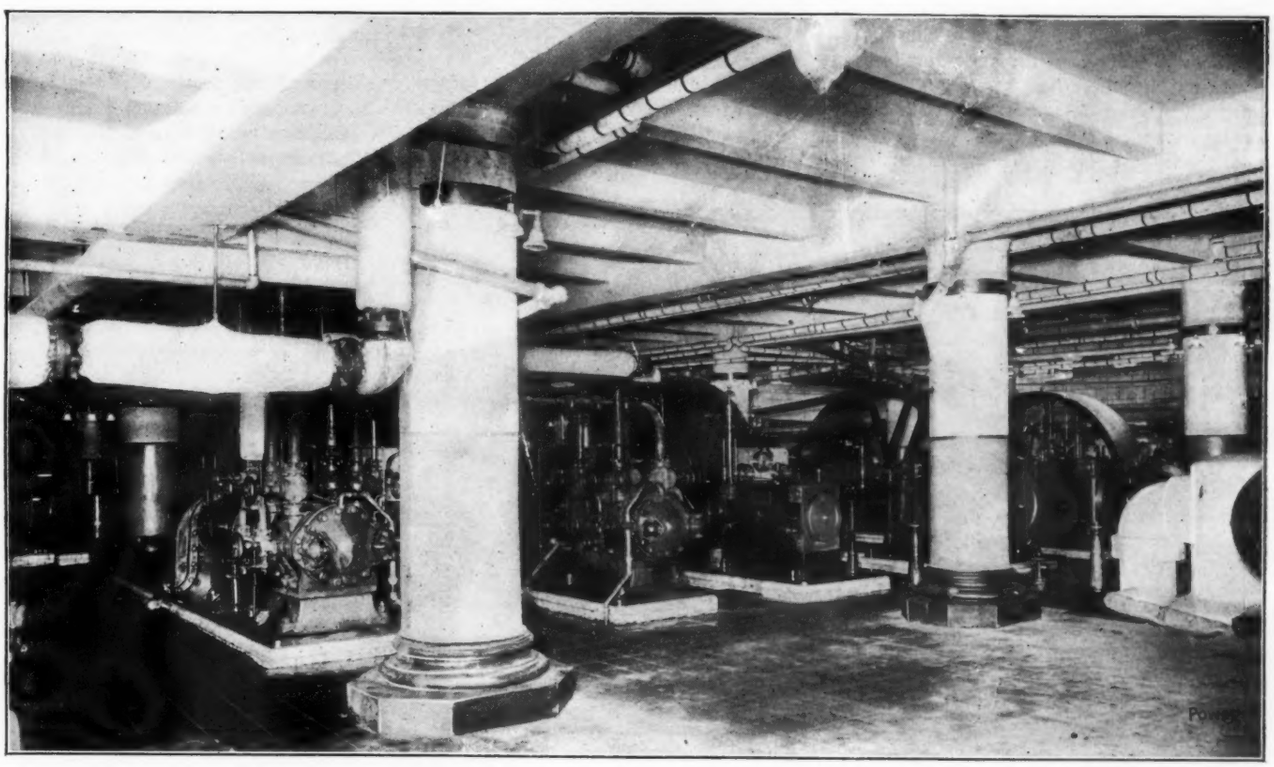


Fig. 1. Partial View of the Engine and Compressor Room

per minute from a pulley on the line shaft. Fig. 1 presents a view of the engine room.

The line shaft is quill driven, divided into seven sections by clutches which are of such size that they are capable of carrying twice the load that the engine will develop. This feature eliminates any trouble from clutches slipping when starting up the compressors with a high back pressure on them. In the center of the shaft are placed the two main clutches which separate the shaft into two sections, each section being driven by one of the two engines. A portion of the line shaft is shown in Fig. 2.

All pulleys are keyed to the line shaft and the ammonia compressors are run as long as the section of shaft carrying the driving pulley is clutched in to the section being driven by the engine driving that half of the shafting. In case it is desired to stop a compressor the clutch driving that section of line shaft which drives the machine must be thrown in an off position. This, of course, stops everything beyond the compressor-driving pulley.

Two 110-kilowatt 250-volt generators are set between the line shaft and the engines and compressors. Both of these machines are belt driven from the shaft by a fixed pulley. If the generator is not required in operation, a clutch on the armature shaft is thrown and the generator stopped regardless as to what is done with the shaft. This arrangement is shown in Fig. 3. These generators furnish electrical energy to the building for lighting and motors. The three-wire system is employed. Each unit has its own switchboard at the machine on which are mounted the main switches and circuit-breakers.

At the extreme ends of the line shaft are two belt-driven air compressors. An adjustable idler pulley controls the operation of each machine. If a machine is not wanted the idler pulley is lifted from the belt and the belt is then easily removed from the driving pulley, or the clutch driving the section of shafting to which the compressor is connected can be thrown, cutting it out.

At the back side of the engine room are placed the two brine pumps. One is a simplex steam pump and the other is a triple-plunger pump, belt driven from the line shaft.

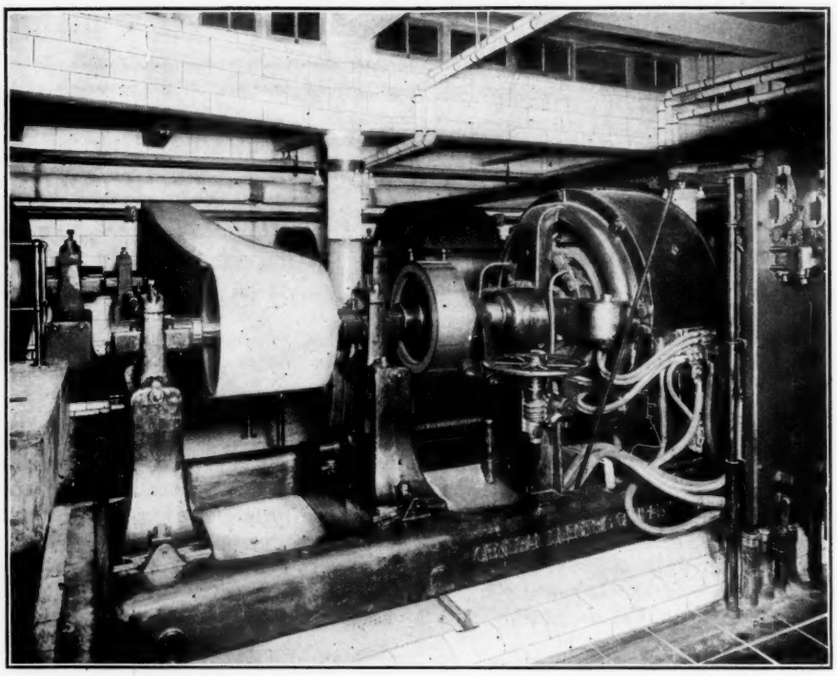


FIG. 3. BELT-DRIVEN GENERATOR AND CLUTCH

There is also a simplex steam pump which supplies circulating water to the surface condenser from a well and one centrifugal turbine-driven pump which is held as a reserve unit for the same purpose.

The two simplex boiler-feed pumps are set in a corner of the engine room next to the boiler room. One is held as a

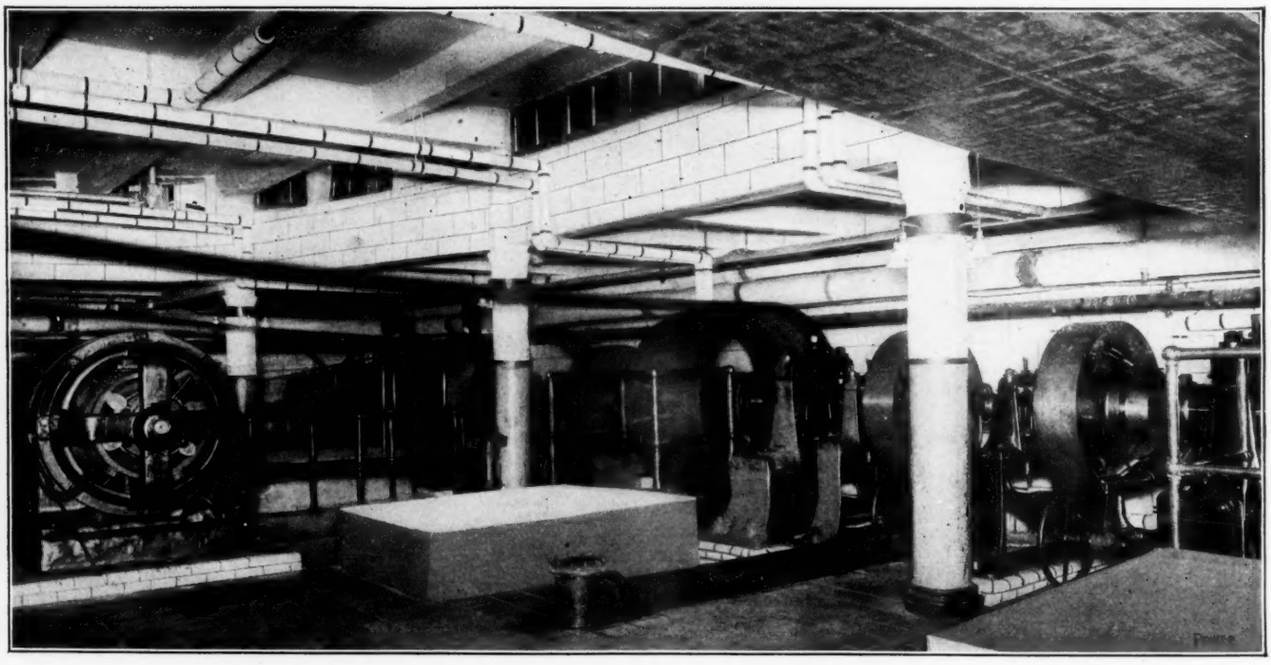


FIG. 2. LINE SHAFT, SHOWING CLUTCHES

reserve. Both have 12 and 7 by 14-inch cylinders.

Passing to the boiler room there are three 350-horsepower Babcock & Wilcox boilers. Two are set on one side of the boiler room and the other is set on the opposite side. These boilers are set in a concrete pit or pan 9 feet below the engine-room floor. The concrete pan was necessary on account of the flow of water from underground sources. Natural draft is used and the furnaces are equipped with dumping grates. Fig. 4 shows a portion of the boiler room.

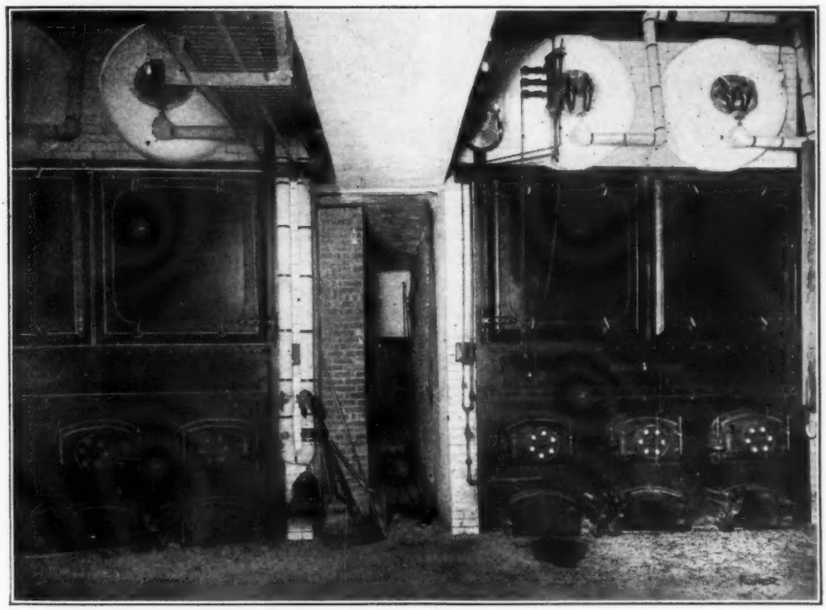


FIG. 4. TWO OF THE THREE WATER-TUBE BOILERS

Coal is delivered from the street into a storage bin under the sidewalk and is conveyed to the boiler room in a 1-ton coal car, which runs on an industrial railway. The car is pushed in front of the boilers and the charge of coal is taken from it and fired to the furnace.

One surface condenser serves both steam engines, although with the present load but one engine is necessary. The condenser contains 1600 square feet of cooling surface and is connected to a 6 and 14 by 10-inch steam-driven dry-vacuum air pump. The circulating water, 57 degrees Fahrenheit, is supplied from the well under the engine-room floor, and after passing through a double-pipe ammonia condenser it flows through the steam condenser and is then elevated into a standpipe on the outside of the building to be used for scrubbing and general washing purposes. The well water is not used for ice making on account of the quantity of magnesia contained in it. The water of condensation is pumped from the hotwell and is used in making ice. A plan view of the plant is shown in Fig. 5.

There are double-pipe ammonia condensers, made up of 2- and 3-inch extra-heavy pipe, 12 pipes high, and the water flows through six pipes in each stack of coils. These coils and brine-cooling pipes are placed in a room separate from the main building and are located on the second floor. The cooling coils are each provided with bottom drains. The wing in which they are set adjoins the room in which the can freezing takes place. The plant has a capacity of 100 tons of ice per day, which is a side issue, as the main work is that of sterilizing milk, of which 126,000 pounds is sterilized and cooled from a temperature of 140 degrees to between 35 and 40 degrees. It requires but eight hours to handle this quantity of milk, which represents 1400 cans, each weighing 90 pounds.

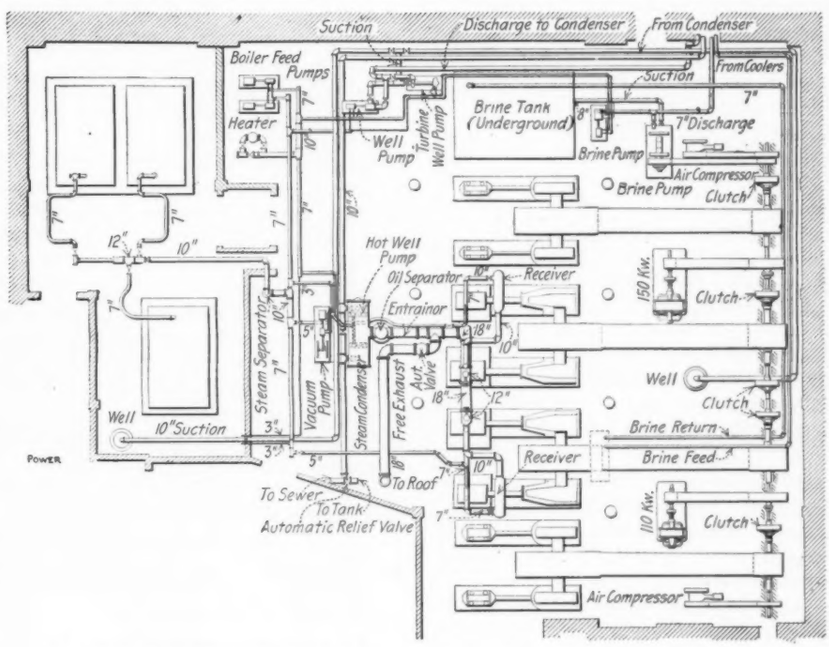


FIG. 5. PLAN VIEW OF THE ENGINE, COMPRESSOR AND BOILER ROOMS

The cooling process is to run the hot milk down over two sections of cooling pipes which are covered by a corrugated casing. The bottom and third row of tubes contain brine and the passage of milk over the pipe casing brings the temperature down to about 35 degrees Fahrenheit, when the milk is in a fit condition to bottle ready for delivery to the consumer.

Under ordinary circumstances it would be necessary to have two ammonia compressors as the back pressure used in making ice and cooling milk differ. In this plant it requires 20 pounds back pressure for cooling the milk and but 15 pounds for cooling the brine. These two pressures are obtained from the same machine as the two ends of the ammonia-compressor cylinder are connected to a separate line, one running to the brine cooler and the other to milk-cooling tubes. In case the milk-cooling tubes are not in use an equalizing valve is opened between the two ends of the cylinder and the same pressure is used on both sides.

In filling ice cans it frequently happens that the can will hang up on the coils in the brine and the man attending to the filling will in most instances give the can a kick to move it away from the pipe. The can, being one-half or two-thirds full of water, falls with considerable force on the coil below and in time a leak will develop. To prevent this taking place the pipe coils opposite each can are protected by a flat strap and as the can fills with water it rubs against the band and slips into place without catching on the pipe coils. This and other ideas were incorporated by George F. Hill, who is the designing engineer for the company.

The Steam Turbine for Future Work*

By Edwin D. Dreyfus

Steam turbines are now available in units of 30,000 kilowatts capacity and nearly 20,000,000 horsepower capacity have been built.

The paper deals with early difficulties and the modifications made, especially in the Westinghouse practice to overcome them.

It argues for the turbines as against the piston engine, and for the reaction as against the impulse type, and discusses the questions of ratings and guarantees.

*Abstract of paper read before the Indiana Electric Light Association at South Bend.

The increasing volume of turbine work, reaching upward of 20,000,000 of horsepower in the short time elapsed since its advent, truly establishes the permanency of this type of prime mover in relation to our economic power problems.

For electrical supply, the turbine has become commercially available in sizes ranging from a fraction of a kilowatt up to as high a power as 30,000 kilowatts in a single unit, from the diminutive locomotive headlighter to the gigantic engine now demanded by the metropolitan service stations.

(A) *Complete Expansion Turbines* essentially rank first owing to the predominance of their use. These turbines receive steam at the highest steam pressures and temperatures, and expand it continuously to the highest vacuum.

Where high boiler pressures (ordinarily above 175 pounds gage) are used, but a very small part of the turbine is required to withstand the accompanying stresses, as high pressures are confined within small nozzle blocks. With the piston engine, the high-pressure cylinder must safely accommodate these forces. Turbine design involves no rubbing surfaces, so that lubrication under high temperatures requiring special valve and packing design and lubricants is no longer a factor.

The profitable use of a moderately high vacuum is another commendable feature of the turbine, and is readily accomplished without impractical or uncommercial proportion of parts, such as would become necessary with low-pressure cylinders of piston engines.

(B) *Low Pressure Turbines,* up to date, hold a position second to that of the complete-expansion type, since they are capable of receiving steam at approximately the pressure at which a piston engine would exhaust the steam after expanding it throughout its most economical range of operation (boiler pressure to atmosphere) and complete the expansion to high vacuums with the same degree of efficiency—doubling the output of a noncondensing reciprocating-engine plant without increased coal consumption. The actual improvement in a reconstructed engine plant will usually be from 10 to 50 per cent. or more, according to whether the plant was condensing or noncondensing prior to including the low-pressure turbine. The low-pressure turbine is valuable on the following counts:

- **First—Reducing operating expense.....**
  - 1—Fuel.
  - 2—Oil.
  - 3—Labor.
  - 4—Repairs.
- **Second—Advancing the value of plant investment.....**
  - 1—By restoring the utility of the engines, thus preserving their existing rated worth.
  - 2—Obtaining increased capacity at the lowest possible unit cost.
- **Third—Improving the service.....**
  - 1—By simplifying operation, reducing the number of condensers, or for a former noncondensing plant providing a good source of boiler feed.
  - 2—In securing better cyclical regulation, an inherent quality of the turbine.
  - 3—Through the small rise in water rate on overloads, mitigating the peak tax on boilers.

The engineering features which may surround the installation of low-pressure turbines assume various forms, based upon plant conditions and methods of operation, and thus introduce these different provisions:

(a) Without governor. Electrically controlled through synchronizing force of generator.

(b) Governor control, with auxiliary live-steam admission.

(c) Interlinking turbine and belted engines through synchronous motor.

(d) Automatic bypassing of low-pressure steam to condenser.

(e) Use of a reserve high-pressure element.

(f) Heat regenerators, accumulators and storage systems.

(C) *Noncondensing Turbines* have also found a field of usefulness, to a limited extent, however, as main units. They are extensively used for auxiliary service. Where exhaust steam is used abundantly, this would prove the proper sphere for the noncondensing design. Should the heat supply become an important element of the utility service or of an industrial company's operations, a strictly noncondensing unit, or perhaps a number of them, may be recommended, providing the electrical load reduces in the warm-weather months in a fair proportion to the heating demand occasioned in winter.

With the recent advance in turbine design, it is most difficult to show cause for the use of a reciprocating engine on the ground that it consumes less steam when operating with atmospheric exhaust or higher back pressures.

In the results obtained with a drum-type Parsons turbine, with 7 pounds back pressure, the disparity is only about 5 per cent. at full rating, compared with an engine in excellent order, the water rates being 39.8 and 38 pounds per kilowatt-hour for the turbine and engine respectively. This difference vanishes on loads less than one half. The fact should be borne in mind that with maladjustment and leakage of valves and pistons, the steam engine may not be constantly maintained under these so termed test conditions. A well designed turbine should not perceptibly suffer in operation, and impartial tests confirm this fact. Further, it should be remembered that there is a saving in oil, labor and investment with the turbine, and a considerable reduction in maintenance expense of the distributing mains, with entire freedom from oil, which will greatly overshadow the slightly better fuel economy of the piston engine. And inasmuch as the exhaust is fed to heating mains, the somewhat greater consumption of the turbine may in no sense represent a disadvantage, but, on the contrary, may prove most desirable.

(D) *Bleeder-type Turbines* owe their existence to the necessity for a mixed lighting and heating supply from a central power station. While in some plants —chiefly large ones—the complete-expansion turbines and the noncondensing type may be successfully coördinated to produce the highest economies in all directions, both the moderate- and small-sized stations, with a dissimilar fluctuation of light and heating loads throughout the day, month and year, would find it virtually impossible to regulate their equipment for constantly attaining the most efficient results. It would, moreover, probably call for a greater station investment to provide adequate flexibility.

In compound-condensing engine stations, it has been a very general practice in cases of this kind to draw steam from the receiver, which becomes practical at all loads with engines having the cutoff on the high- and low-pressure cylinders parallel. In early turbine designs, an improvised expedient was followed to a partial extent by tapping steam from a given stage in which the pressure under any reasonable load

would not fall below that maintained in the heating system, thus guarding against any interference with the supply or service. This method of operation was accompanied by two disadvantages: First, a limited low-pressure steam supply only being available through this means; because with light load the pressure at the stage which is bled will fall below the pressure in the heating system, and, second, a pressure-reducing valve was necessarily introduced between the turbine and heating system, thus producing a loss in throttling the steam.

Such diversified requirements in joint heat and electrical demand led the turbine engineer to devise a method by which both the heating and electrical supply would be automatically and economically delivered in accordance with the demands of the systems. The most effective and dependable solution has been the location of a pressure-controlled valve between the high- and low-pressure sections of the turbine, automatically diverting to the heating system the exact amount of steam required and at precisely the predetermined pressure.

This design is commercially designated the "automatic bleeder" turbine, and in moderate capacities promises an interesting issue in the new era of utility service.

Through the employment of a special constant-pressure valve between a system of reciprocating engines and a low-pressure turbine, an exactly similar function to the bleeder turbine is secured which deserves careful thought in the extension of the older plants containing steam engines.

Electric-power production has created, as is well known, a demand for the turbine far in excess of all other stationary uses combined, and this result is obvious for dual reasons: First, the turbine is preëminently high speed and its general adoption was realized through the successful development of high-speed and direct-coupled generators, and, second, the significant growth of electricity as a modern convenience.

Lighting, being the greater necessity, has brought the higher-frequency (60 cycles) units forward in moderate-sized stations. Large plants with a heavy direct-current load and rotary substations mainly employ 25 cycles. Railway and general power apparatus have heretofore operated at 25 cycles, with occasional exceptions of 15 cycles, or direct-current generation, it being understood that as a rule direct current for railways is obtained through rotary conversion.

The foregoing partial classification, including 60- and 25-cycle service chiefly, comes within the realm of compatible speeds of the turbine and generator. Lower speeds, necessitated by 15-cycle and direct-current work, compel a compromise of the efficiency and the mechanical structure of the two elements.

Through improvements in design and manufacture, large reduction gears have become feasible, thus interpolating between the most desirable speeds of the turbine and generator, respectively. However, direct-coupled generating units of about 300 kilowatts and under are being suitably fitted to the needs of excitation sets and corresponding direct-current service where low amperage obtains and high economy is not essential.

Centrifugal boiler-feed pumps for plants of about 2000 boiler horsepower, ranging in size from 15 to 100 brake horsepower, establish another class wherein direct connection of the turbine proves commercially practical.

The wisdom of immediately coupling the turbine to large direct-current generators and centrifugal pumps, screw propellers in marine practice and other slow-speed applications has now been fairly decided by the successful large flexible gear, giving rise to unrestricted latitude in design of the component parts with respect to each other.

A single-reduction gear, or else a train of gears, has also brought the rolling-mill requirements within the bounds of the steam turbine.

An obstacle in early turbine construction was the involved cylinder design which militated against uniformity in expansion and contraction of the parts. This was unrelentingly assailed by adversaries of the reaction type and was really productive of occasional blade trouble, the reason for which was very plain in the study of the old line of turbines. While the explanation is very simple in its retrospect, it obviously required this ordeal in its commercial development stage to bring it to the point of success which it has now attained. Early difficulties were due principally to the equalizer ports and supports being cast integral with the cylinder in all important sizes, producing variation in the depth of metal at different points, thus causing the cylinder to slightly camber with temperature changes. This trouble has been eliminated in all improved designs by separating these exterior parts from the cylinder proper. As this practice has now been in effect for three years, there has been ample experience in the operation of a great many units of this advanced construction* to prove its merits.

Evidently there were cases in the early days of numerous blade mishaps from contact due to the distortion above noted. Also different qualities of blades have been employed until a successful composition and quality were secured. Steel- and copper-clad blades, which were used in certain stages of turbine history, soon gave out where the steam possessed any corrosive properties. However, a great many turbines so equipped have not shown any perceptible signs of blade deterioration after several years' constant operation where the boiler feed was uncontaminated. A case in point occurs right here in South Bend, where a 1500-kilowatt Parsons turbine having steel blades has just been opened up and found in excellent condition after four years' constant service.

Heavy blade and disk construction may, to the lay mind, be construed as *prima facie* evidence of strength and rigidity, but any attempt to unduly reinforce its construction may defeat the end in view.

No abnormal strains should be introduced in the turbine in changing from condensing to noncondensing operation and *vice versa*. Should the outer rim of a disk be more quickly lowered in temperature in converting to condensing service, the plate may buckle, thus rendering the unit not only unserviceable but unsafe.

If the feed water is chemically active, it is important that the design freely allow lining the cylinder because of wall corrosion.

Inherent Characteristics of Types

The elementary distinction between "impulse" and "reaction" design is that the former employ high relative velocities across the blades with equal pressure on either side of the rotating buckets, whereas in reaction blading low relative velocities obtain and a drop in pressure—or, in other words, expansion—also progresses in the blades themselves, which really constitute small nozzles.

Use of low velocities entails the least abrasive action of blade surfaces from steam jets, the wear being some function of the square of the relative steam speeds. The effect becomes more serious in the presence of moisture and provides a logical reason for establishing reaction blading in all low-pressure stages. To offset the effect of high-velocity moist steam in the impulse type, increased superheating is being recommended to delay the occurrence of saturation, or the dew point, to the last stage—in other terms, to insure dry steam throughout the expansion. This naturally requires more costly boiler outlay and piping systems with the attending liability of greater maintenance expense. A gain may be derived from the viewpoint of repairs, but not in the sense of fuel economy. Prominent European builders of impulse turbines in taking cognizance of these facts largely subdivide the low-pressure stages to attain low steam velocities.

Since in the reaction type the greater part of the work is performed as the steam issues from the blades, the necessity of a sharp and well preserved entrance angle is of comparatively little moment. But in the impulse type the greater part of the dynamic energy in the steam jet is exerted on entering the

*See paper before Engineers Society of Western Pennsylvania and the Pittsburg Railway Club.

buckets, so that it is very necessary that the blades and direction of the jet be correctly maintained. Thus it is manifest that the reaction turbine will show greater permanency as regards efficiency, either in case of slight wear or scale deposits on the blades.

Unequal pressure on the sides of the rotating blades in the reaction type creates an end thrust which must be properly counterbalanced. Large capacities induced the development of the now well known double-flow turbine which not only solved the balancing problem but enabled the use of higher rotative speeds and provided large blade areas in the final stages, both factors of economy. Although the impulse type does not ordinarily experience any unbalancing of pressures on either side of the disks, an accumulation of foreign matter upon the buckets may restrict the steam sufficiently and produce a considerable force in an axial direction, due to resulting impact. Being without means for counteracting heavy unbalancing, the thrust bearing may become dangerously overloaded. More advantages accrue from the use of a great many small blades in reaction turbines than are at first apparent. An accidental collision of the rotating and stationary elements may only result at the most in stripping a small number of blades, but even under this slightly crippled condition it may be safely continued in service, a practice generally prohibitive with the disk type with heavy blades and thin shafts due to the lurking danger of vibration from an unbalanced rotor.

There is a misleading idea that one type of turbine may be designed for a greater degree of efficiency when high vacuums are used, but it is a fact that no actual difference exists, as may be easily demonstrated graphically. However, the change in economy of any particular type with change in vacuum will depend to some extent upon the number of stages or rows of blades which it contains; therefore, the turbine of fewer rows or stages is more sensitive to changes under operating conditions and will more rapidly decline in efficiency if the auxiliary equipment is not maintained up to the original standard. Besides, the striving and expense warranted in maintaining high vacuums is plainly debatable when the greater auxiliary power and investment are fully reckoned. It is simply an economic problem which in reality settles itself in any particular installation.

Regulation and Operating Qualities

Stability in operation is essential in all power stations, large and small. Swinging of load between various units may, if not corrected, become so aggravated as to impair or jeopardize the service rendered by the plant. While wide regulation from no load to full load is preferred in the parallel operation of alternators, it does not relieve the governing mechanism from the duty of promptly responding to load changes. To effect smooth regulation and obviate the tendencies to race and hunt, the "fly-ball" regulator must be sufficiently powerful to overcome any momentary sticking or binding, and the inertia and friction of rest without hesitancy. In hydraulically operated valves, the relayed action of the governor should not be retarded through the necessity of accelerating the long columns of oil communicating between the pilot valve and the operating cylinders.

Simplicity in valve and governor mechanism is paramount to insure instant action at any critical moment. Gradual steam admission has the advantage of a smooth regulation curve, and the governor must control but a single valve. Where each step in valve operation represents, say, 300 horsepower, the sluggish action or sticking of any one valve may bring about unfortunate results.

The governor or regulator should be supplied by forced lubrication and incased for the safety of the operatives.

When in service, the turbine should require a minimum of attention under any and all variations in load. It has largely scored over the reciprocating engine in the matter of small attendance.

In large stations chiefly, and in other plants where the loads remain very uniform for long periods or change gradually, these features may not assume such importance as indicated. But, allowing that the swings on the station are of an appreciable amplitude, as occurs with interurban-railway loads and in industrial plants having rolls, bulldozers, elevators and similar intermittently operating apparatus, sensitive regulation is demanded where office lighting is furnished from the same source of current.

Efficiencies

Scarcely any reference to the comparative economics of the reciprocating engine and the turbine need be made; their relationship is already well established. In strictly condensing service the turbine, as previously noted, is more efficient, excepting perhaps in the smaller units. For noncondensing work the engine may show a somewhat higher heat efficiency, but it is often the reverse when final capital economy is considered.

There is much to be said, however, regarding the performance characteristics of different turbines. Various builds could not be expected to coincide in the results they produce for important reasons, since blading formation and proportions are the governing factors. The superior efficiency of nozzles over buckets has been thoroughly settled; hence turbines employing the reaction principle, being all constituted of nozzles, should surpass other types by from 5 to 15 per cent., notwithstanding radial leakages. According to all records, this type has developed the best results thus far obtained. The proper measure of turbine performance is the efficiency ratio or Rankine cycle efficiency; that is, the ratio of the equivalent energy transformed into effective work to the heat energy actually available. Water rates alone do not exhibit the true economy of the turbine, as low steam consumption may be obtained by sacrificing the other station equipment.

Ratings

Within the last three years a new reference for rating generating units and other electrical power apparatus has come into use to a limited extent. This has taken the form of basing the full-load capacity on the greatest amount of power which may be delivered by the machine continuously without dangerous heating or strains or seriously falling off in speed. The capacity thus determined is termed a "maximum rating." Previously, the more conservative practice provided all important machinery of this class with a continuous marginal overload of 25 per cent., which was distinguished as the "normal rating." Each method of rating is to be respectively indorsed under appropriate circumstances. Only where there is definite knowledge that the unit will not be compelled to operate constantly at some greater capacity than fixed upon should maximum ratings be employed. This removes the conservatism so essential in important service and should therefore be confined to special cases.

Turbines rated on a maximum basis are incapable of carrying full load should the vacuum be accidentally lost, which might embarrass the operation of the plant. Boilers possess sufficient overload capacity to provide the increased steam required to run the turbine noncondensing, and the boiler plant should not be rated at its maximum output as a higher efficiency obtains at a lower rating.

For the different ratings the design of the turbine would not be necessarily changed to produce better light-load economy for the normal rated turbine as no advantage would accrue even with a swinging load. It would mean, though, in the maximum rated turbine that all the power possible was being forced from the same frame used for the machine when normally rated at lower capacity.

The unit cost per kilowatt of a maximum rated turbine is necessarily lower than the normal rated machine, while it may be identical in every respect. Delusions of this nature have frequently caused real misapprehensions.

An allowance for system power factors is also very important, its neglect in many plants having very unfortunately resulted in burning out the generator and disabling the unit.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

Gelser Automatic Check Valve

The Gelser automatic water-gage check valve is designed to shut off the steam and water the instant the gage glass breaks. It consists of an outer casing in which there is a plunger valve and a shaft for resetting the valve after the glass has been replaced.

The plunger valve is pivotally mounted as shown in the illustrations, and is so located that its ball nose is directly opposite the tapered opening in the tubular stem, which is screwed into the wall of the regulator. The tapering inlet hole increases the velocity and so directs the discharging steam and water against the back of the plunger valve, the instant the gage glass breaks, that the latter is instantly forced shut to its seat. In Fig. 1 the valve is shown ready for service.

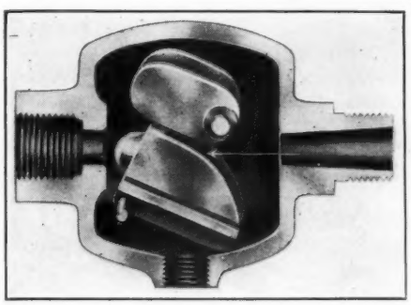


FIG. 1. READY FOR SERVICE

Under normal operating conditions the pressure is equal on both sides of the plunger valve. When the gage glass breaks, the full boiler pressure is directed against the pocket in the plunger valve and forces this valve closed to its seat, instantly shutting off the steam and water, as shown in Fig. 2.

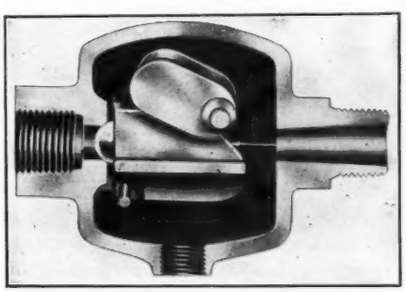


FIG. 2. CLOSED POSITION

The check valves are cleaned of sediment by blowing off with first one drain cock and then the other. In case the plunger valve should stick after automatically closing, it may easily be opened and reset by turning it into position ready for service with the operating shaft, as shown in Fig. 3.

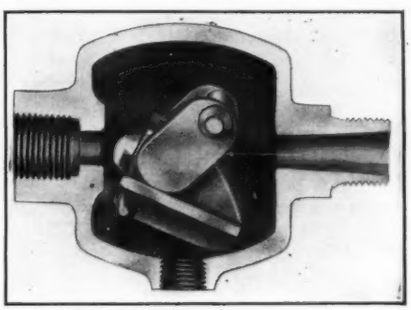


FIG. 3. READY FOR RESETTING

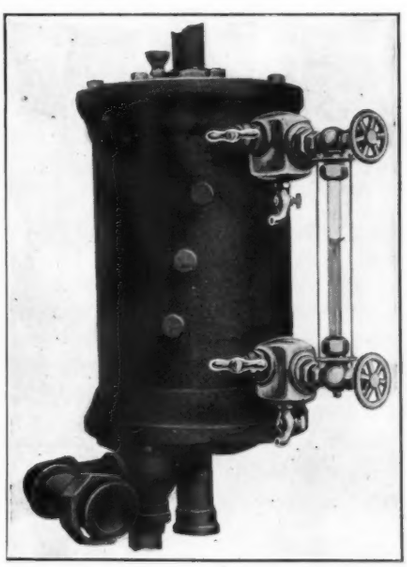
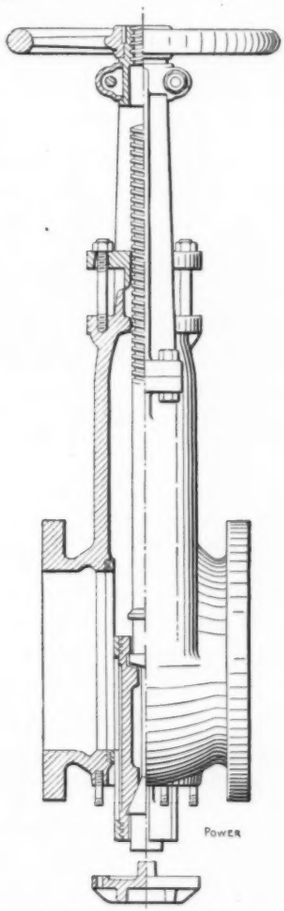


FIG. 4. DEVICE ATTACHED TO FEED-WATER REGULATOR

A side elevation of the check valve attached to a feed-water regulator is shown in Fig. 4. This device is manufactured by the Long Grate Bar Company, Buffalo, N. Y.

Banks Gate Valve

The accompanying illustrations show a new type of gate valve of the double-disk, internal-wedge parallel-seat type. This valve is designed for exposed line work. The chief advantage lies in the accessibility of the inside moving parts, all of which may be removed through the opening created by the removal of the bottom cap on the rising-stem type by rotating the handwheel until the spindle is disengaged from the threaded collar. Renewals of any worn or broken internal parts are thus easily effected and the valve is out of commission but a very short time if a new body ring is needed. The opening in the bottom of the body is brought up close to the flange of the ring, so that a special wrench can be easily inserted in the port opening of the ring, and by means of three small lugs cast on the ring, it is easily removed.



BANKS GATE VALVE

The wedging surfaces are placed on the inside of the disks to prevent any wear from the flow of the vapor or liquid passing through the port openings. The casting of the body and bonnet in one piece is made feasible by providing an opening in the bottom of the body proper, and it tends to greater strength in the casting and the general construction.

This valve is suitable for use with superheated steam, as the casing, cap and disks are of steel, and the body rings, disk rings, spindle and spreader of monel metal. On the brass valves the cap is screwed in place, no bolts being used. This valve is the invention of Frederick R. Banks, Paterson, N. J.

Pasadena Municipal Lighting Plant

In the annual report of the Pasadena, Cal., municipal lighting plant, recently filed by City Auditor Kellog, it is stated that the plant, established at a preliminary cost of about $200,000 and now valued at $500,000, has, with a 5-cent lighting rate furnished revenues of $110,900.71 to the city for the fiscal year ending July 30, 1911. Of this amount $70,268.20 represents the sale of commercial power, and $40,632.51 as saved by the city for street-lighting and public building service.

During the past year $71,631 has been expended in extensions to the system. Within the next two years, the present valuation is estimated to increase 50 per cent., or to $750,000, by proposed additions to the plant and distributing lines.

Water Rights in Washington

When the dam across the mouth of Rock lake, in Whitman county, Cal., was planned by the Palouse Irrigation and Power Company, of Palouse, to provide a storage reservoir of approximately 6600 acres for use during the summer season, property owners in the district brought legal action to enjoin its construction. They claimed that it would prevent the flow of flood waters which annually submerged their lands, and renewed the soil with a rich silt. They were granted an injunction in the lower court, which was sustained by the State Supreme Court in the following decision:

"A riparian owner has the right to the natural flow of the waters in their natural and accustomed channels, without diminution or alteration, subject only to the same right and use in every other riparian owner. Water may not be gathered into reservoirs for the future use, when it may best suit the convenience of one riparian owner, and thus deprive other riparian owners of their use and service of the stream in its natural condition, unless such right is exercised under a valid prior appropriation. This court has always recognized the doctrine of prior appropriation of water on public lands, as superior to all other claims, while it has also recognized the common law right of the prior owner against all but bona fide prior appropriations."

Polytechnic Institute Lectures on Power Plant Design

Fifteen lectures on "Power-plant Design" will be delivered during the evening technical courses of the Polytechnic Institute, by George A. Orrok, the consulting professor of power engineering at the institute and mechanical engineer of the New York Edison Company.

These lectures will be given every Monday evening, commencing October 2, at 7:30 o'clock, and will include the following topics: Results obtained and restrictions governing power-plant design, ratings, centers of load, distribution, types of industrial power plants, architecture; boilers, materials and construction; furnaces, grates and stokers; chimneys; fuels and ash-handling devices; valves, pumps, heaters and meters; steam piping, engines and auxiliaries, condensers, indicators; estimates, specifications and power-plant operation.

Sale of Rogue River Electric Company

One of the largest transfers of property in Oregon took place when the Rogue River Electric Company, of Medford, was purchased by the Siskiyou Electric Power and Light Company, of Yreka, Cal., for $3,300,000. The purchasers come into control of power plants and a lighting and power system which covers the Rogue River valley territory, together with a hydroelectric power plant now under construction on the Rogue river, near Prospect, which is estimated to cost $800,000.

The Siskiyou Electric Light and Power Company, of which J. W. Churchill is president, owns the Oregon properties of the Ashland Power and Light and the Klamath Power companies. With its recent purchase, the company's power plants now have a generating capacity of about 80,000 horsepower, at low water, tied in with a transmission system of 800 miles.

Large California Power Project

Permission having been granted to dam the Colorado river, work has commenced on one of the largest power and irrigation projects yet attempted in the Southwest. The initial dam will be constructed at the Bullhead site in Pyramid cañon, about 40 miles north of Needles, Cal. It will be of the "arch dam" type, constructed of reinforced concrete, about 140 feet high and 400 feet wide, and will form a lake approximately eight miles wide, with an average depth of 100 feet. This lake will be used to irrigate the Chuckwalla valley and Palo Verde Mesa, 120 miles distant.

Electric energy is to be developed from the impounded waters, and power plants of many thousand horsepower will be installed. A series of electrically operated pumping stations will be erected at eight-mile intervals to lift the water in a distance of 27 miles, 300 feet above the river bed into an irrigation system formed of distributing canals, thus providing sufficient volume to reclaim nearly 300,000 acres of land.

Power will also be furnished to various mining interests in this section, and an extensive system of transmission lines is planned. The work will be done on the unit plan, each item as completed being placed in operation. About five years will be needed to accomplish the entire project.

The Chuckwalla Development Company, Blythe, Cal., of which R. M. Teague, San Dimas, Cal., is president, has inaugurated this enterprise and several million dollars will be spent to complete it.

BOOKS RECEIVED

THE SOIL SOLUTION. By Frank K. Cameron. The Chemical Publishing Company. Easton, Penn. One hundred and thirty-six pages, 5½x9 inches; tables. . Price, $1.25.

TESTING OF ENGINES, BOILERS AND AUXILIARY MACHINERY. By W. W. F. Pullen. The Scientific Publishing Company, Manchester, England. Seven hundred and twenty-one pages, 5¼x 8½ inches; 733 illustrations. Price, 12s. 6d.

PERSONAL

At 202 Equitable building, Boston, Mass., the Oil City Boiler Works, of Oil City, Penn., has opened headquarters for looking after the sale of Geary water-tube boilers in the New England States. George P. Flinn has been placed in charge.

Peter Eyermann, known to our readers through various contributions, largely upon gas-engine subjects, and situated at Witkowitz Mähren, Austria, has been appointed to read a paper on American blast furnaces, steel works and rolling-mill equipment before the Austrian Society of Mechanical Engineers and Architects in Vienna. He will be very much pleased to receive at the above address photographs, prints, descriptions, etc., which would be useful in this connection, especially those showing the use of blast-furnace gas under steam boilers, and those descriptive of blowing and rolling-mill engines.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

AT a recent Engineers' Convention a friend of ours overheard the following conversation between two delegates:

"John, have you been to the Exhibition Hall yet?"

"No, Frank, I've been too busy with convention matters and besides there would be no use in my wasting time in there. I can see everything that's exhibited here, and a whole lot more, in the advertising pages of POWER."

Here was a man who realized that POWER'S Selling Section is actually a great, continuous *national* convention of everything *valuable* that is used in the power plant—

An exhibition without crowds and noise—

One that an engineer can have brought right to his own plant or home every week—

One that he can inspect and study when he has time and inclination.

Understand, he didn't mean that reading an advertisement about an article entirely takes the place of a personal examination of the article itself—

But—this engineer did hit on one of the most valuable features of modern advertising—

The great saving of time it makes possible for the buyer and consumer.

Advertising will make you acquainted with the main features and advantages of an article in the *easiest*, *quickest* way possible.

It enables the reader to proceed by the good old process of elimination, and to concentrate on very nearly what he wants and needs for his particular purpose—

All without the trouble, time-waste and expense of hunting up all the articles and going to see them.

If you'll just try to imagine modern buying *without* the help of advertising, you'll see how things have progressed since advertising became a safe and sane profession.

Because advertising saves *your* time is one reason why manufacturers advertise their products.

Which is *another* good reason why you should be a constant and careful follower of the ads in your paper.

Are you?

BUSINESS ITEMS

Jesse G. Haydock, who was formerly associated with E. J. Rooksby in another concern, has recently entered the firm of E. J. Rooksby & Co., 435 North Eleventh street, Philadelphia, Penn.

J. S. Gothran, of Charlotte, N. C., has been appointed the sales agent of the Terry Steam Turbine Company for North and South Carolina. Mr. Gothran's offices will continue to be at Charlotte, N. C., where he has long been identified with the trade.

The Schaeffer & Budenberg Manufacturing Company, of Magdeburg, Germany, is erecting an auxiliary plant in Warsaw, Russia, which will employ about one thousand hands. This is the parent concern of the Schaeffer & Budenberg Manufacturing Company, of Brooklyn, N. Y., and manufactures the same line of high-grade steam specialties.

Owing to the rapid increase of business since taking over the Silliken plant, the Nova Scotia Car Works, Halifax, has found it necessary to duplicate its power plant. The original plant was supplied by the Robb Engineering Company and the duplicate order has been placed with the same concern. The new installation will consist of a 600-horsepower Corliss engine for direct connection to its electric generator, three 200-horsepower return-tubular boilers with self-supporting steel smoke stack five feet diameter, ninety feet high, also feed-water heater, piping and other accessories.

The Westinghouse Electric and Manufacturing Company has received a contract recently from the United States quartermaster's department, for furnishing the necessary transformers, wattmeters and switchboards for the army post located at Fort Bliss, Texas, and at the Angel Island recruit depot, near San Francisco. The post is to have an electric-lighting system installed, energy being purchased from the local electric power company. The apparatus is for the purpose of distributing, controlling and measuring the current consumed in the various buildings of these army posts.

C. R. Vincent, for many years president of the Ball & Wood Company, has assumed the managership of the "Monel" metal department of the Ruggles-Coles Engineering Company, 50 Church street, New York City, general agents for the Bayonne Casting Company. At its foundry in Bayonne, N. J., the latter company has for some years been making with success castings of this remarkable alloy that is stronger than steel and less corrodible than bronze. Some of these castings range over 25,000 pounds in weight. Sheets, rods, wire and screens of the same metal will also be handled by the company with which Mr. Vincent is associated.

Upon the installation of a new fire pump recently ordered by the city of El Paso, Texas, lower insurance rates will go into effect in that city. The pump that gives this additional fire protection is a 10-inch Buffalo three-stage vertical turbine pump of the submerged type. It will be placed at the bottom of a 50-foot well and when driven by Westinghouse motors at 850 revolutions per minute will deliver 3000 gallons per minute against a total head of 350 feet. This pump will be built in accordance with the requirements of the National Board of Fire Underwriters. The Buffalo Steam Pump Company, Buffalo, N. Y., has the contract.

In May, 1906, the Smooth-On Manufacturing Company, of Jersey City, N. J., sold some corrugated Smooth-On gaskets to the De Lamar Copper Refining Company, of Chrome, N. J. The De Lamar Company on May 16, 1906, wrote the Smooth-On company that it would let it know in a few weeks of its success in the use of the gaskets. On September 12, 1906, it wrote that the gaskets were entirely satisfactory. Recently it wrote another letter saying that the gaskets it installed in 1906, five years ago, have continued to give satisfaction, and given no trouble whatever. A neat folder telling the complete story in detail has just been issued by the Smooth-On Manufacturing Company, 574 Communipaw avenue, Jersey City, N. J., and will be sent to any engineer on application.

NEW EQUIPMENT

Kingsburg, Cal., will erect a new power house.

Waterford, Ont., will equip a new electric-lighting plant.

Hamilton, Ont., will equip a large municipal power plant.

Carlton, Ore., voted $40,000 bonds for a waterworks system.

Edward Syverson, Ironton, Minn., will erect a cold-storage plant.

Richmond, B. C., will equip a new waterworks pumping plant.

Grosse Pointe, Mich., is planning to increase its water-supply system.

The Hotel Oregon, Ashland, Ore., will install a new cold-storage plant.

N. J. Ready, 1018 Central avenue, Indianapolis, Ind., will install a boiler.

Robert W. Howard will install a new electric-light plant at Kentland, Ind.

Sierra Madre, Cal., will install waterworks system at a cost of about $96,000.

Exeter, Cal., has voted $42,000 bonds for installation of waterworks system.

The Hull Electric Company will erect a new power house at Aylmer, Que.

The Union Ice Company, Bakersfield, Cal., will erect an addition to its plant.

F. F. Rogers, 509 East Washington street, Indianapolis, Ind., will install a boiler.

Bills & Boettcher will install a boiler at 341 East Washington street, Indianapolis, Ind.

Pilot Rock, Ore., contemplates the installation of a municipal waterworks system.

The Kansas Ice Company, Newton, Kan., will build an ice plant at Belen, N. M.

The Merchants Heat and Light Company, Indianapolis, Ind., has increased its capital and will install additional equipment.

The United Traction Company is erecting a new transformer station at North Albany, N. Y.

The City Ice Delivery plant, Cleveland, Ohio, will erect another ice plant for manufacturing ice.

Detroit, Mich., is contemplating the erection of a municipal garbage-incinerating plant.

Hermiston, Ore., has voted bonds for installing waterworks system. Cost, about $25,000.

The Pelican Bay Lumber Company, Klamath Falls, Ore., will install an electric-lighting plant.

The city council, New Castle, Ind., has voted $35,000 for improving the water and light plant.

Nance & Hasser, Garfield, Wash., will erect a cold-storage and refrigerating plant on Third street.

F. A. Wilde, Kingman, Ariz., will double the capacity of his power plant. Addition is being erected.

Prince Albert, Sask., will purchase turbines and transformers for a new electric-lighting plant.

The plant of the Sedro Ice and Storage Company, Sedro-Woolley, Wash., was destroyed by fire.

The Western Packing Company, Spirit Lake, Iowa, will rebuild plant recently destroyed by fire.

The Chicago, Milwaukee & St. Paul Railroad will install its own electric plant at Aberdeen, S. D.

W. C. Allen and Adam Roym are considering the erection of an electric-light plant at Arlington, S. D.

The Oxford (Mass.) Water Company will install two new pumps of 400 gallons per minute capacity.

Trenton, Tenn., will vote on issuance of $12,000 bonds for installing a municipal electric-light plant.

The Consumers Ice and Cold Storage Company, Lexington, Ky., will erect a $60,000 addition to its plant.

The Bronx Gas and Electric Company, New York, will issue $80,000 bonds for extending and improving plant.

Wallingford, Conn., will erect an addition to its electric-lighting plant to accommodate three or four boilers.

Plans are being considered by the Light and Water Department, Winchester, Tenn., for a new pumping station.

Asotin, Wash., will install a waterworks system to cost about $35,000. C. H. Green, Portland, Ore., engineer.

Seattle, Wash., has voted $1,000,000 bonds for extension and improvement of its Cedar River waterworks system.

The Northern California Power Company, Sacramento, Cal., is planning to double the capacity of its waterworks system at Willows, Cal.

The trustees of Thousand Island Park, N. Y., plan to erect a new pumping and electric-lighting station. J. P. Lewis, acting president.

The Providence Braid Company, Pawtucket, R. I., is building a new power house and will operate plant by steam instead of electricity.

Equipment will be required for the new substation of the Union Gas and Electric Company, at St. Clair and Gano streets, Cincinnati, Ohio.

The Spring Valley Water Company, San Francisco, Cal., is having plans prepared for a new power plant on Sloat boulevard and Nineteenth avenue.

The Pacific Telephone and Telegraph Company, Portland, Ore., will erect an eight-story building on Oak street and will equip same for main exchange.

The Pacific Power and Light Company, Portland, Ore., is planning to install a lighting and power system at Centerville and at Benton City, Wash.

Pocatello, Idaho, is planning to install a municipal waterworks system to cost about $300,000. City Engineer Congdon is in charge of this work.

The Wheeling (W. Va.) Electric Company is erecting a new plant at Forty-second and Water streets to cost about $700,000. Steam turbines will be installed.

The Alaska Packers Association, San Francisco, Cal, plans to install a number of refrigerating and cold-storage plants on its vessels for the fish industry.

Power-plant equipment will be installed in the new nine-story hotel to be erected by C. A. Hooper, San Francisco, Cal. Cunningham & Politeo, architects.

Several new buildings are being planned for the Connecticut Colony of Epileptics, at Mansfield, Conn., including power and heating plant, water supply, etc.

The Otis Elevator Company will erect an office building at 2-14 Plymouth court, Chicago, Ill., to cost over $1,000,000. Complete power plant will be installed.

The blowing out of a cylinder head of a 1200-horsepower engine in the Greylock Mills, at North Adams, Mass., did about $10,000 damage to engine and building.

The Wilmington & Philadelphia Traction Company has awarded contract for the erection of an addition to its power plant on Buena Vista street, Wilmington, Del.

The Long Beach (Cal.) Consolidated Gas Company is having plans prepared for a new gas plant, which will include engine room, generator house, scrubbers, purifiers, etc.

Bids will be received until September 28, at the office of consulting engineer, F. A. Jones, Youngstown, Ohio, for furnishing plant equipment for the High School building.

The Joint Water Supply Commission, of Yonkers, N. Y., has recommended to Public Works Commissioner Brady the purchase of a 10,000,000-gallon pump for the waterworks.

The Morrison Hotel Company has commenced the erection of a $3,000,000 building at 101-125 West Madison street, Chicago, Ill. Complete power plant will be installed.

The city of Cleveland, Ohio, will vote in November on the issuance of $2,000,000 bonds for a new municipal lighting plant.

Proposals will be received until 11 a.m., October 12, at the United States Engineer Office, Wheeling, W. Va., for the construction of power house and installation of one 115-horsepower boiler, one steam-driven air compressor, two air receivers, feed-water heater, feed-water pump, etc., at dam No. 19 Ohio river.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

TRAVELER WANTED, with a knowledge of boiler house work and consulting engineers. Box 507, POWER.

WANTED—Thoroughly competent steam specialty salesman: one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

WANTED—Salesmen traveling among engineers to sell Ideal metallic packing on commission. Ideal Metallic Packing Co., South Stillwater, Minn.

SALESMEN can make big commissions selling our guaranteed metallic packings as a side line. Address High-Speed Metallic Packing Co., 305 N. Michigan Ave., Chicago.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

ONE ENGINEER in each town to represent us, your choice of any indicator outfit on the market as a free premium; give your home address and firm employed by. The Olson Mfg. Co., Manitowoc, Wis.

WANTED—One first-class marine engine and boiler draftsman, $5.04 per diem; a competitive examination will be held for the above position, October 18. For further information address "Commandant," Navy Yard, Charleston, S. C.

AGENTS WANTED—To sell lubricating oils, belts, hose, paint and varnish, for power machinery, to factories, mills, auto owners, stores, threshers; exclusive territory to right party; oil experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, Ohio.

SELLING AGENTS wanted in important centers for Betson's plastic fire brick; it readily interests everyone having the usual troubles with boiler and furnace fire brick arches and lining. See page 141 of this issue. Betson Plastic Fire Brick Co., Rome, N. Y.

STEAM ENGINEER to take charge of power plant, New England paper mill, operating one thousand engine horsepower; none but thoroughly competent engineers need apply; references required; state salary and present employment, signed. "Steam Engineer," Care POWER.

AN ENGINEER; one who has had at least ten years' power station experience and understands boilers, turbines, engines and general uptodate apparatus; an engineer in charge of a medium size generating station; salary $2000 per year or over to the right man; answer, giving age, experience and copies of references. Box 503, POWER.

ENGINEER or specialty salesman in each town to furnish lists of gasket users and information on new installations and act as our agent for "Duplex Akron" corrugated copper gaskets; "Sure Shot" steel superheat gaskets; Lead manhole gaskets; Lead ammonia gaskets, and Valve-Tite metallic packing; you have this information; we will pay for it; you don't have to make the sale, our goods and prices will do that. Address Dept. C, Akron Metallic Gasket Co., Akron, Ohio.

SITUATIONS WANTED

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AN ICE ENGINEER thirty years old, and with twelve years' experience in construction and running, wishes a position as chief; references. Box 510, POWER.

CHIEF ENGINEER; have handled some most modern compound and condensing power and lighting plants; hold first-class reputation and technical education; take a position anywhere. Reply Box 509, POWER.

AS CHIEF in plant of 1000 horsepower or smaller, or as assistant in larger; have fair technical education, first-class Indiana license and six years' continuous experience in the engine room; satisfaction guaranteed; 26 years old, married and strictly temperate; can furnish good reference; am employed at present as hoisting engineer. Address Box 500, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS—C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

WANTED—One second-hand 75- or 100-kilowatt direct-current, belt type, 500-volt generator. Alberger Gas Engine Co., Buffalo, N. Y.

WANTED—A De La Vergne fuel-oil engine of 85 or 100 horsepower; must be in good condition. Address Kraeuter & Co., 18th Ave., Newark, N. J.

WANTED—A high-speed automatic, or a Corliss engine, 100 to 125 horsepower; must be in good condition; give full particulars and price. Ed. Laird, Crandon, Wis.

PATENTS—Herbert Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. I make a free search and report if patent can be had and the exact cost.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

ENGINEERS AND FIREMEN—Send 10 cents in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2703 Cass Avenue, St. Louis, Mo.

IS THERE SOME QUESTION confronting you, either of a mechanical or electrical nature, that demands professional advice or ingenuity? If so, write C. W. Morgan, B. S., M. E., Corresponding Consultant, 3122 South Park Ave., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—In running condition, one 35-horsepower automatic Jacobson gasolene engine. Box 508, POWER.

FOR SALE—8x10 Skinner engine, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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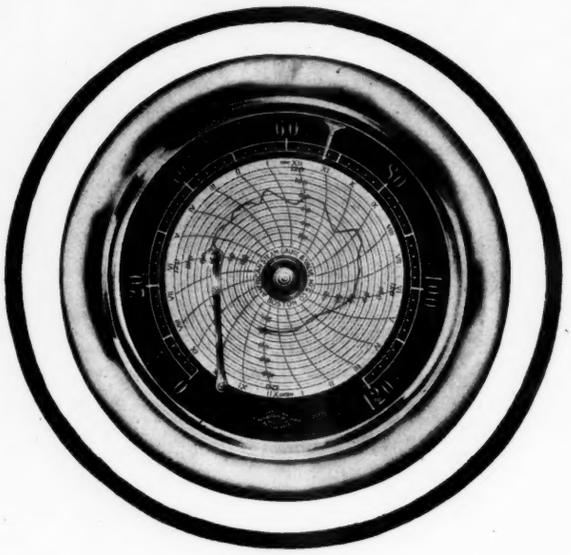

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